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Heating Piping & Air Conditioning

DESIGN
INSTALLATION
OPERATION
MAINTENANCE

CONTENTS . . PAGE 89

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BUILDINGS

ge 35: Journal Section of the American Society of Heating and Ventilating Engineers

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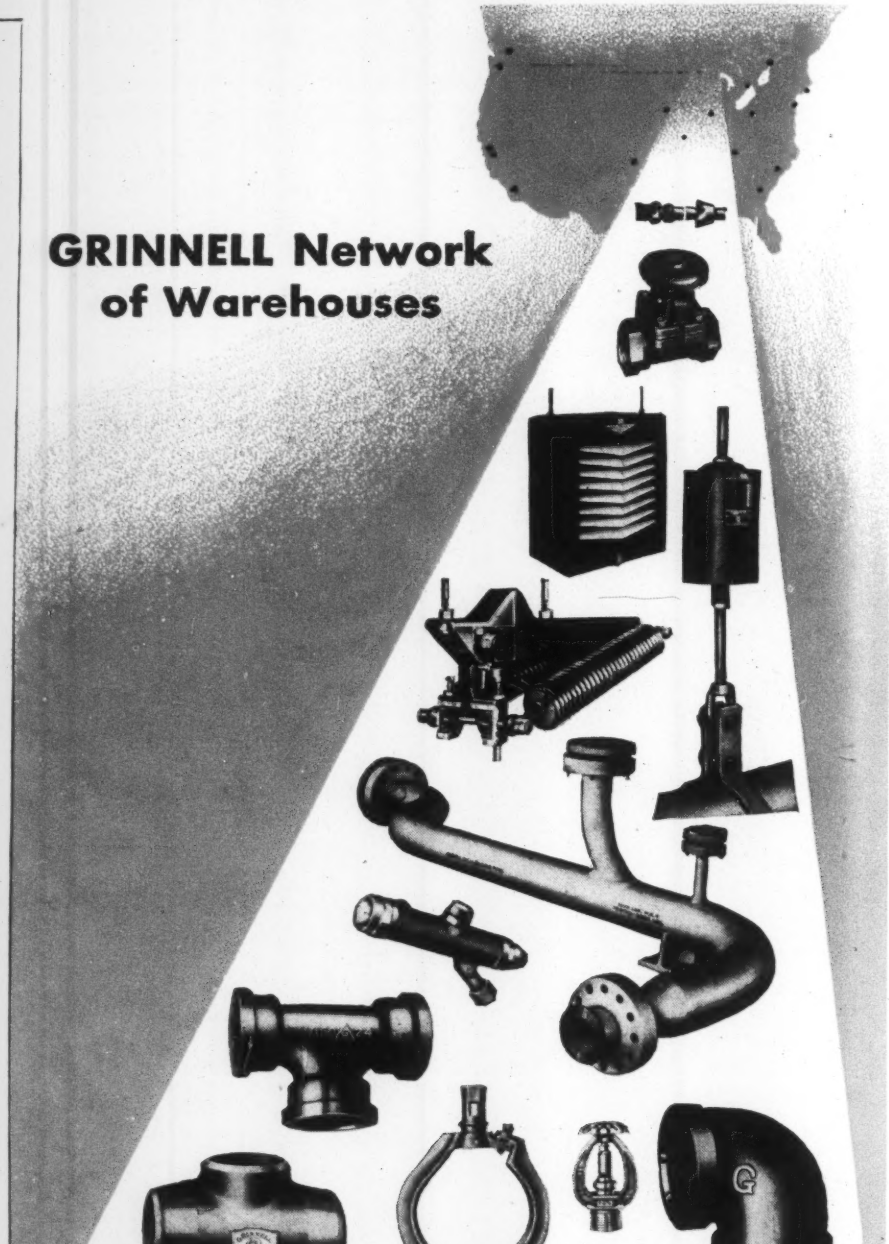

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THE EDITOR'S PAGES

DO YOU MAKE USE OF ALL THESE FEATURES?

The beginning of a new year is traditionally a period of inventory-taking, and perhaps the occasion for making a few resolutions. While we've never been much at making New Year's resolutions — perhaps because of the well-justified fear that we may not be too good at living up to them—we have been taking inventory of the regular features which appear in Heating, Piping & Air Conditioning each month in addition to the major articles and the valuable papers which are published in the ASHVE Journal Section. Our first 1945 issue seems like a good time to bring them to your attention, too.

For example, Sam Lewis' page each month (page 7 of the main editorial section this time) brings you informal comment on heating, piping, and air conditioning matters by a well-known consulting engineer, a member of HPAC's board of consulting and contributing editors. This month, Mr. Lewis talks about forced circulation hot water heating for building groups.

"Open for Discussion" (page 34) is another monthly department which enjoys a regular and wide readership. In its columns, we follow the custom of engineering meetings in allowing a place for comment, criticism, and questions from the "audience." Your views for publication in "Open for Discussion" are invited; we hope that during the year a great number of HPAC's readers will want to discuss articles which have been published, or comment on topics of specific interest to heating, piping, or air conditioning engineers or contractors.

We're combining some of our regular editorial material in a "department" this month which is planned to be a more or less regular feature; it's called Practical Pointers on Operation, Maintenance, Repair, Alteration, Extension, and is on pages 25 to 33 of the editorial section. You will note that it is comprised of short, practical articles aimed to be of particular interest and value to the men who take over after a heating, a piping, or an air conditioning system has been designed and the original installation has been completed. We'd like to know what you think of this feature, and what sort of information you'd like to see in it during the coming months.

In the back section, there are several monthly departments. Equipment Developments reviews each month the new and improved equipment announced by manufacturers and sometimes has an item or two about an interesting installation. This department, together with the one entitled Recent Trade Literature, will keep you up-to-date on sources of supply. To facilitate your getting further information about new and improved equipment, or copies of manufacturer's literature, we publish a coupon (page 211) which you can check and return to HPAC. Lots of readers use it.

In the back section, too, is a monthly listing of coming Meetings and Conventions, with information on papers to be presented or subjects to be discussed of direct interest to HPAC's readers. New Books and Reports are reviewed—and frequently abstracted—in the department of that name.

The department entitled WPB . . . OPA . . . PAW . . . Etc., summarizes briefly each month the latest amendments, revisions, and other changes in the various orders of the War Production Board, the Office of Price Administration, and other such bodies. It is "must" reading in these days, of course.

As to The Editor's Pages, which you are now reading, we fill them up with news notes and comment —sometimes significant and sometimes otherwise. Maybe that should be our New Year's resolution—cut out the "otherwise."

11TH DIRECTORY SECTION APPEARS THIS MONTH

Starting in January 1935, Heating, Piping & Air Conditioning has published in its first issue each year a complete Directory Section of Heating, Piping & Air Conditioning Equipment for Industry and Large Buildings. The Directory Section for 1945 appears this month; the first such classification to be compiled in its field, this listing is the most complete, the most carefully prepared, the most logically arranged and cross-indexed, and consequently the most useful. At least, that's the way we feel; so do many of our readers, and we hope you will, too, as you refer to it throughout the year.

The Directory Section is divided into three parts. In the first, the products are classified, all manufacturers being listed under the numerous classifications. The second part lists, alphabetically, all trade names which are not the same as or easily identifiable from the manufacturer's name. Part three gives the complete street addresses for all manufacturers whose names appear in the Directory Section. The names of those manufacturers advertising in *this issue* of HPAC are spotted throughout the Directory Section, as a service to users of the listings.

In addition to the Directory Section, the regular quota of articles and other editorial material—and the Journal Section of the American Society of Heating and Ventilating Engineers — are published this month, as every month.

PLANNING NEW BUILDINGS FOR AUTOMOBILE DEALERS

An architectural competition for the design of automobile dealers' places of business in which $55,000 in prizes will be awarded by General Motors was announced last month by Albert Bradley, executive vice-president of the corporation. The competition was decided on "after many dealers had indicated their postwar plans included enlarging their present buildings or building new places of business."

The competition will run to midnight of April 16. Entrants are to register with the Architectural Forum, 350 Fifth Ave., New York 1, N.Y., and will receive details of the competition as well as an outline of the steps to be taken to submit drawings.

* * * * *

BUY AN EXTRA WAR BOND

AMERICAN GAS ASSOCIATION ISSUES STUDIES ON AIR CONDITIONING DUCTS AND WATER PROBLEMS

The American Gas Association, 420 Lexington Ave., New York 17, N. Y., recently issued two research bulletins on air conditioning, which supplement the earlier AGA publication entitled Gas Summer Air Conditioning. Identified as research bulletins Nos. 30 and 31, respectively, the new booklets cover performance characteristics of air duct systems, including a review of methods for design and calculation of pressure losses in these systems, and water problems encountered with summer air conditioning equipment.

In the duct bulletin, it is stated that:

"Data selected from present charts for friction losses in straight ducts should apparently be adjusted by application of a rather large safety factor if pressure loss through fittings is computed on a basis of equivalent length of straight duct. Data on pressure loss through elbows presupposes even distribution of the air in the approach duct since all research has apparently been conducted with straightening vanes in the duct ahead of the elbow under test. Under actual conditions encountered in the field, the placement of elbows and fittings close together disturbs the distribution of air in the duct so that often one-half of the cross-sectional area of a duct or fitting is actually carrying as much as 80 per cent of the air volume. Further research is required to determine the effect of this entrance factor on both ducts and fittings. . . . . Additional data are needed on the effect on pressure losses of double elbows, U-fittings, various types of branch off-takes, expansion fittings, splitters, scoops and dampers.

"There is a large amount of data available on fan operation covering horsepower requirements with various loads, air flow rates at various speeds and different pressures, but there are no data on effect of fan outlet on air flow. Data obtained at the American Gas Association testing laboratories have indicated the necessity of knowledge of the outlet velocity conditions if pressure loss in the duct immediately following the blower is to be obtained. Variable results may be obtained from the same blower when discharging into different types of plenums. A difference in performance was also noted when using identical outlets but operating against a variable static pressure. In the course of the field survey during this investigation it was found that in none of the air conditioning units did the blowers discharge into similar fittings. In the various systems the blower discharged horizontally into an expansion fitting, into an elbow attached directly to the blower outlet, or into a vertical plenum chamber attached to the outlet. Research conducted to determine the effect of varying methods of discharge on the pressure loss caused by the different types of fittings would be helpful.

"An experienced design engineer with knowledge gained from performance of a large number of installations can usually make allowance for unknown factors affecting pressure losses in a system and by careful correlation of such factors with elements of the system on which accurate data are available can design a system that should give satisfactory performance. However, accurate design of air distribution would be greatly facilitated by additional basic data on flow-pressure characteristics of all fittings needed for practical installations and the effect of positioning of such fittings on their flow characteristics. It would be helpful if all available data could be studied, the best abstracted, and combined in one publication.

"If all factors are taken into account, it seems reasonable to conclude that use of the velocity head loss method of computing pressure loss in duct systems will give results closer to the observed data than any other method."

THE EDITOR'S PAGES

According to the bulletin on water problems:

"Use of water in an air conditioning system may give rise to corrosion, scale, and algae problems. Before installation of air conditioning systems in a territory a study should first be made of water conditions and the necessity of water treatment determined. If cooling towers are required, information on the need for water treatment should be obtained from those in the community who are experienced in use of large volumes of water. Engineers connected with city ice plants, theaters, and department stores with large air conditioning installations, and large power plants using spray ponds, are usually reliable sources of information on the subject. A study of the [gas] companies' own experience with gas water heaters will often provide information on the possibility of scale deposits being formed. If the results of such studies indicate possible difficulties a water chemist or water treatment engineering company should be consulted.

"When cooling systems are first installed pump pressures should be determined frequently during the first year of operation as a means of detecting deposition of scale. If no increase in pressure is found during this time, semi-annual checks of pump pressure should prove sufficient for this purpose during the following years. If scale accumulates in the system, analysis should be made both of the water in the system and of scale or corrosion deposits so that the cause can be diagnosed and correct treatment prescribed. All systems should be kept under careful observation so that any change in performance due to corrosion, scale, or algae can be detected immediately. Prompt application of protective measures will then serve to prolong life of the system and maintain its efficiency."

The research work represented by these two bulletins was conducted by the AGA testing laboratories under the supervision of the association's joint committee on gas summer air conditioning.

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Heating Piping & Air Conditioning

with which is merged the Aerologist

Design, Installation, Operation, and Maintenance: Industrial, Commercial, and Large Buildings

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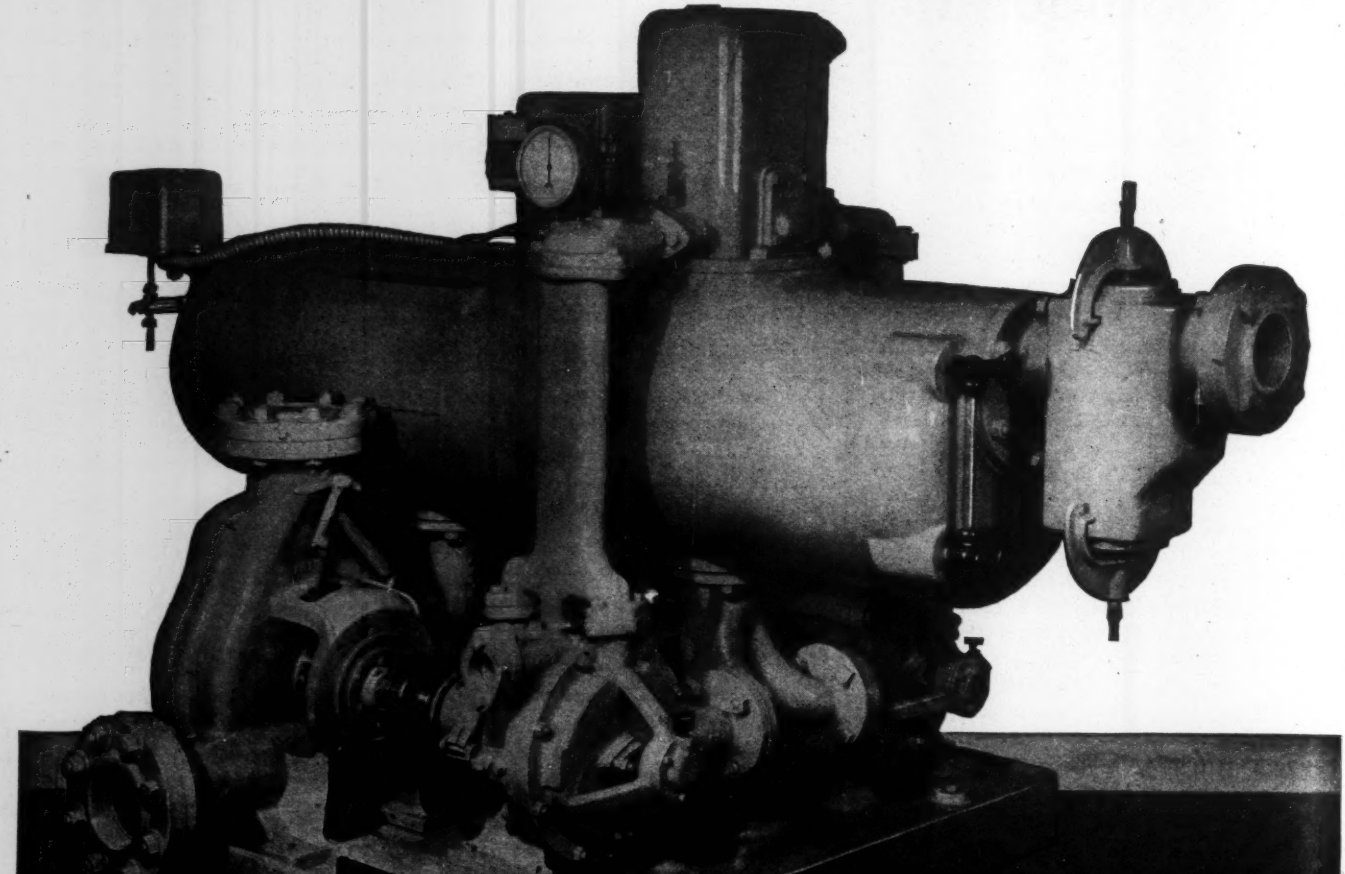
Where Heat Must Not Fail— Install this SAFE Heating Pump!



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REPORT FROM INDUSTRY:

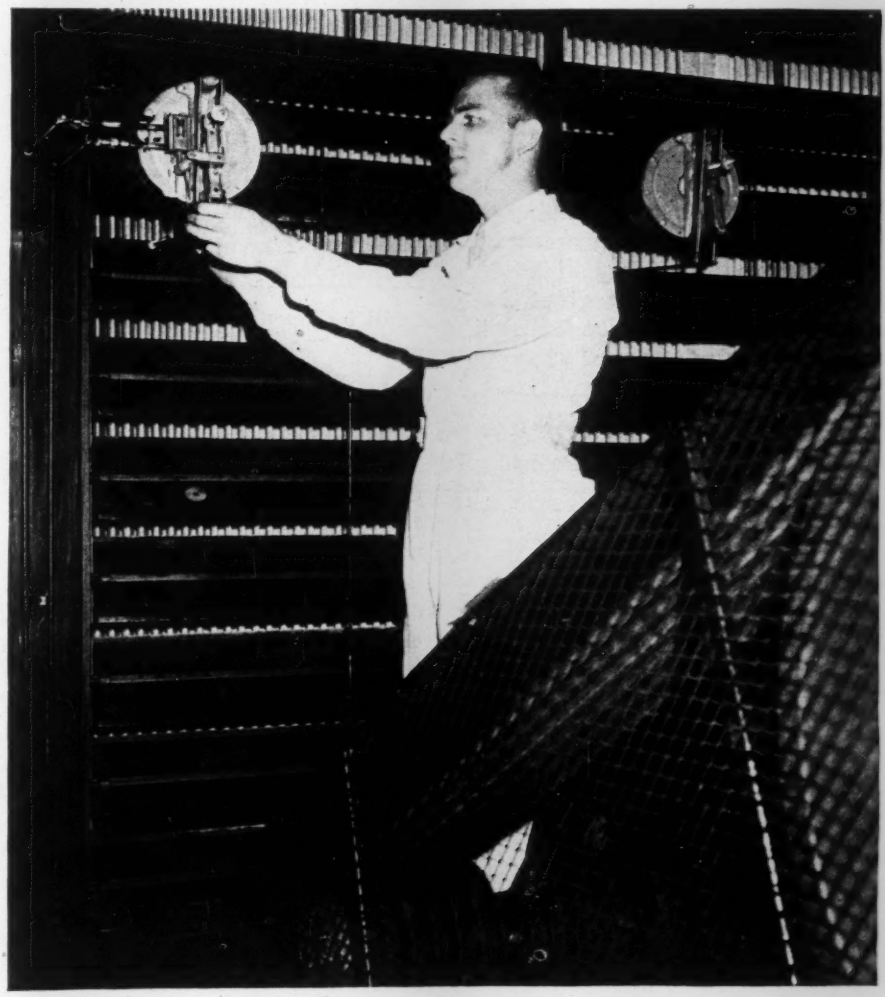
Should Factories Be Air Conditioned?

By R. D. Tutt, Supervisor of Air Conditioning, W. E. Goohs, Assistant to Plant Engineer in Charge of Power Division, and F. G. Tykle, Plant Engineer, Allison Division, General Motors Corporation

EARLY IN 1938, when the General Motors Corp. decided to expand the Allison Div. facilities at Indianapolis, Ind., to accommodate the production of liquid cooled aircraft power, much consideration was given the type of building which would be constructed, the type of machine tools, lighting, power, air conditioning and ventilation, costs, efficiency, etc. When the decision was made that the building be totally air conditioned, it was the result of many factors:

1) The war picture at this time was growing sufficiently grave that it was considered that the ability to completely "blackout" all metropolitan and manufacturing areas against aerial attack was necessary and to provide facilities for accomplishing this result and simplify construction, strong support was received from government sources, leading architects and contractors to build so-called flat topped, windowless buildings for defense manufacturing. For example, quoting from an address by Walter L. Fleisher, nationally known consulting mechanical engineer, upon his return from an inspection of England's manufacturing resources: "If war should come to America, then the objective of attack would be our industrial plants turning out emergency material. These plants working day and night, if lighted like a burning torch, would be the finest targets for night attacks of planes. They would have to blackout in order to avoid attack. Closed doors and windows, or better still, no windows or buried or half buried structures are the alternative. What ventilation there was would have to be artificial. Twenty-four hours a day, six or seven days a week, may be the role of industries before the menace of Europe has passed. The wear and tear on the worker, the nerve strain coincidental with the physical labor, is not unlikely to impair the health of the worker, but to impair his efficiency as well. To allay this unfortunate condition and to produce more and better goods, air conditioning can do much. The fumes of cutting oils, the gases of engines, and the sweat will all tend to a deterioration of product that the very necessity of increased production cannot afford."

2) It was found by estimate and later substantiated by fact that it was possible to construct the average blackout type building with air conditioning at a cheaper cost per sq ft of manufacturing space than it was to build the conventional monitor roof, window type building. The blackout type building tends to conserve heat by doing



An air conditioning supervisor at the Allison Division makes an adjustment

away with loose fitting sash and large crack areas, and eliminates the cost of window washing reglazing, etc. This cost is normally as high as 2c per sq ft of floor space per yr. It makes possible the constancy of lighting that is not possible with daylight. This has proved valuable in inspection work and various manufacturing operations.

Working to Close Tolerances

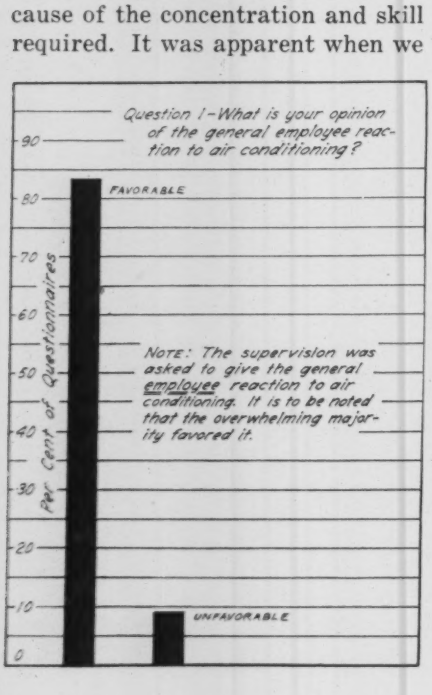
3) The ability to work to closer tolerances in the manufacturing of the Allison engine was highly necessary. Control of etching of parts due to perspiration of workmen by controlling humidities was also of prime importance. According to O. T. Kreusser, general manager of the Allison Div., "Manufacturing requirements in the new plant created conditions to be met which gave us an unusual opportunity to try out advanced thinking. Our program for the manufacture of aircraft engines for the United States Army calls for a high degree of precision and careful handling of materials. Temperature changes affect the micrometric gages and precision machines workmen constantly must use. Perspiration in this climate may cause etching on the highly polished metal surface, sometimes from just a sweaty fingerprint. Fine lighting is required for accurate reading of gages and observance of work by the operators. Comfort of workmen is unusually important because of the concentration and skill required. It was apparent when we laid out the plant that maintenance of a steady comfortable temperature, proper humidity, and proper dust count in the manufacturing building would be essential. Since air conditioning and artificial lighting were required, we were able to dispense with windows and monitor roofs, which contributed to economical construction."

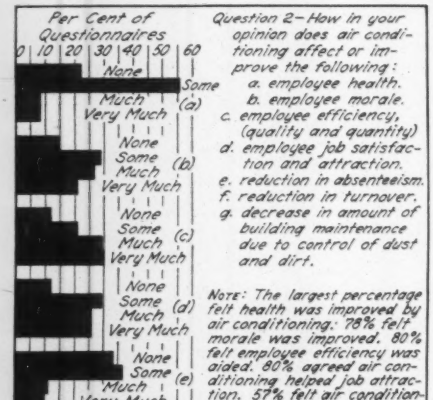
Nor was Allison the only company who believed this to be true. Quoting Samuel R. Lewis, consulting mechanical engineer: "It is known to be impracticable, for instance, to build high powered airplane engines without control of the moisture and dust in the air."

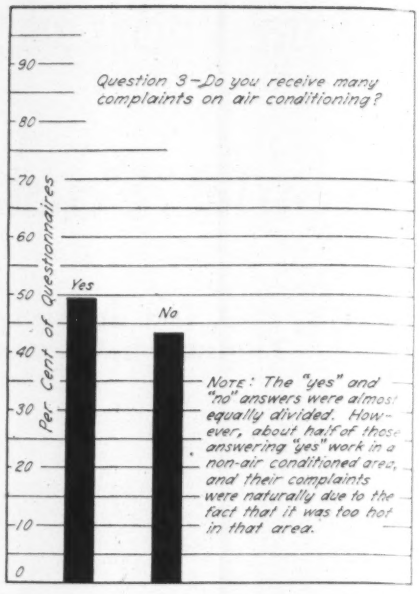
Further, as early as 1937, an automobile maker found "that air conditioning pays in increased production, more accurate processing, steadier output, and particularly increased efficiency and better health of all classes of workmen. . . . Uniform temperature has been found essential in precision manufacturing of parts and we find the rooms in which cylinders are diamond bored, the room in which crankshafts are ground to close tolerances, and similar manufacturing areas employ apparatus to both heat and cool the air."

The Warren Telechron Co., at Ashland, Mass., found that "dust control and humidity control is of prime importance in preventing excessive wear and motor failure in Telechron motors."

Certain materials used in our manufacture "are not necessarily susceptible to air relative humidity, but are affected greatly by variations of air temperatures during processing, which variations alter the precision of micrometer dimensions demanding accuracy. In this class are the machining and finishing of metals, engine cylinders and parts, chronometers, machine tools, and precision instrument manufacturing," to quote E. P. Heckel, consulting engineer.


Question 1—What is your opinion of the general employee reaction to air conditioning?
Per Cent of Questionnaires
FAVORABLE
UNFAVORABLE
NOTE: The supervision was asked to give the general employee reaction to air conditioning. It is to be noted that the overwhelming majority favored it.


Per Cent of Questionnaires
Question 2—How in your opinion does air conditioning affect or improve the following:
a. employee health.
b. employee morale.
c. employee efficiency, (quality and quantity)
d. employee job satisfaction and attraction.
e. reduction in absenteeism.
f. reduction in turnover.
g. decrease in amount of building maintenance due to control of dust and dirt.
None
Some
Much
Very Much
NOTE: The largest percentage felt health was improved by air conditioning; 78% felt morale was improved. 80% felt employee efficiency was aided. 80% agreed air conditioning helped job attraction. 57% felt air conditioning had some effect on absenteeism. Many did not answer question about turnover, probably due to the variety of factors involved, but 52% felt air conditioning had some effect in reducing turnover. 70% felt air conditioning decreased amount of building maintenance, though a large percentage did not answer this question.


Question 3—Do you receive many complaints on air conditioning?
Per Cent of Questionnaires
Yes
No
NOTE: The "yes" and "no" answers were almost equally divided. However, about half of those answering "yes" work in a non-air conditioned area, and their complaints were naturally due to the fact that it was too hot in that area.

Health of Workers

4) Under the high pressure strain of defense or war manufacturing, it is obvious that every possible consideration should be given to providing the best possible working conditions in order to keep the efficiency and health of workmen at the peak. According to Dr. A. G. Young, director of the Corey Hill hospital, "Air conditioning has proven effective in combating the common cold because infective agents do not thrive under effective air conditioning. Absentee records for one large utility company show a reduction of absenteeism from illness of 28 per cent. A large newspaper plant found absenteeism due to illness reduced 30 per cent (by the use of air conditioning)." Absenteeism records also showed that decisive savings may be expected, as noted in a speech by E. L. Ellingwood, consulting engineer, in which he remarked: "In one important job of mine, the company continued to keep absence records. After the installation of air conditioning and over a four year period the absences due to illness had been reduced 38 per cent.

SUMMARY—There is little doubt that experiences with pre-war and wartime air conditioning installations in industrial plants forecast a great expansion of controlled temperature, humidity, and other atmospheric conditions in postwar factories. Control of the air in industry is helping to win the war production battle, and will do much to make manufacturing of a host of products more efficient in the postwar years.

To find out something of the advantages of industrial air conditioning, a questionnaire was circulated last summer to 634 division heads, general foremen, and foremen at two air conditioned plants of the Allison Div. of General Motors Corp., asking for a cross-section of the attitude of Allison employees toward air conditioning. Eleven questions were asked, and the replies are summarized in the accompanying charts. The advantages of these air conditioned windowless plants may be listed as follows:

1) **Better constancy of lighting.**
2) **Cheaper building construction cost per square foot.**
3) **Conservation of heat due to reduction in crack area and glass exposure, making possible smaller boiler installations.**
4) **Reducing dust and dirt due to pressurizing the building and adequate filtering equipment with consequent decrease in building maintenance.**
5) **Ability to work to closer tolerance due to constancy of temperature.**
6) **Control of etching and rusting of parts due to perspiration and moisture control.**
7) **Steadier and increased output due to:**
   a) **Reduction of absenteeism.**
   b) **Better health of the employees.**
   c) **Attraction of a better grade of workers.**
   d) **Increase in employee efficiency both as regards quantity and quality of work produced.**
8) **Increased safety due to improvement in working conditions.**
9) **Saving in labor and material cost in cleaning and maintenance of windows and skylights.**
10) **Decrease of 10 per cent (according to questionnaire) in general scrap.**
11) **A better labor union reaction to working conditions.**

From the results given here, it would seem that the question asked above—Should factories be air conditioned?—usually will be answered "Yes". Certainly, there should be very good reasons at hand before deciding against air conditioning a new industrial plant or against modernizing an existing plant by means of air conditioning.

Air conditioning was given full credit. In this plant the improvement took place fairly uniformly throughout all seasons of the year, regardless of weather conditions."

The health of the worker as a result of heat has been noted in a talk by L. T. Avery, Avery Engineering Co., in which he remarked: "A recent item in the Cleveland Plain Dealer reads as follows: 'An alarming increase in home front casualties—industrial workers killed in accidents and others succumbing to maladies brought on by the feverish pitch of war production work—has been noticeable in the Cleveland area, Coroner Samuel R. Gerber revealed today. Thus far in 1943, county morgue records show 51 fatal accidents in industrial plants, and this accounts for but 60 per cent of the estimated total, he said. He contrasted these figures with 34 industrial fatalities during 1940, 93 in 1941, and 98 in 1942.' But accidents are not the only lamentable factor, the coroner said. He cited 1643 fatalities due to heart attacks, received at the morgue thus far this year, saying that many of these were caused by long hours and hard work of war industry workers. This raises a question in my mind as to whether the war pitch caused these accidents or whether it was the heat. Cleveland has had an unusually warm summer this year, particularly with high humidities. It has always been my opinion that workers in these hot industrial plants slow down in the summertime and cannot stand the pace and are not expected to. Under the pressure of war undoubtedly many of these men try to do work both under hotter weather conditions and for longer hours than has been the case in the past. Certainly we know that the summer brings more heart failures than the winter due to the extra strain on the heart during the hot weather. Comfort cooling may be actually the means of keeping a man on the job instead of having him sick in a hospital or dead on the morgue bench. Cooling will prove its own value and its worth in prosecuting the war, and we should not stand idly by when people say, 'Oh, we can get along without comfort cooling for the duration.' One thousand, six hundred and forty-three fatalities in Cleveland alone due to heart attacks this summer is something you can't laugh off."

Safety and increased efficiency in human production was the topic of an interesting analysis by Dr. Willis Carrier in an address before the American Conference of Industrial Physicians and Surgeons in August 1938. Quoting from Dr. Carrier: "Under adverse conditions in the Marovelho gold mine in Brazil, 20 fatal accidents occurred in 16 months prior to the installation of air conditioning when the effective temperature in the mine was 90.5 F. During the 16 months after the installation of such equipment only six such accidents occurred. Owing to improved working conditions, output increased 13 per cent."

5) It has been the opinion of industrialists and personnel men that as a result of air conditioning, those plants offering it would command a preference in the quality of the workmen over those plants not offering this feature. This

again was illustrated by a point in Dr. Carrier's speech. "Under one management in Virginia there were side by side an old cotton mill and a new air conditioned one. Improvement in working conditions in the new mill was so great that it proved a real inducement for the workers. There was always a waiting list of applicants from which the more skilled and efficient workmen could be selected. Obviously the condition greatly improved the efficiency of the new mill apart from the gain due to the better processing of the product."

Many questionnaire surveys in air conditioned buildings have indicated that better than 70 per cent of all employees were entirely satisfied with the conditions over a full year's operation, while less than 30 per cent were either unappreciative of air conditioning or had definite complaints against it. Industrial air conditioning has naturally acquired some criticism from a comfort standpoint due to the fact that certain temperatures and humidities must be held to give a required manufacturing condition, or where space temperature was forced so low by fuel rationing as to border on the edge of the "comfort zone."

Cost of Air Conditioning

As a result of reports and facts similar to these, Allison plant No. 3 was built of "blackout" construction, windowless, and completely air conditioned, including office areas. The Allison Div. thus became one of the very first plants to manufacture within a completely air conditioned building. The complete installation cost approximately $250 per ton, an amount equal to approximately $1,120,000, and conditioned about 1,000,000 sq ft of floor space. This, of course, resulted in a cost of $1.12 per sq ft of space conditioned. Of the total cost, 20 per cent was for refrigeration equipment, 29 per cent was for air handling systems (fans, coils, filters, motors), 20.4 per cent was for sheet metal (ducts, toilet exhausts, grilles and outlets, casings, etc.), 5.85 per cent was for temperature control, 4.5 per cent was for heat exchangers, cooling towers, circulating pumps, etc., 6.85 per cent was for circulating water piping, steam piping, expansion joints, etc., 2.15 per cent for insulation for above piping, 0.52 per cent for instrumentation, 0.33 per cent was for painting, and 10.4 per cent was for freight, installation labor, supervision, overhead, profit, and insurance. (Boiler cost was not considered because it would require a similar amount, or possibly more, of capacity to heat the building by any other means.)

Amortizing this cost over a 20 yr period, the cost to be written off would be approximately $56,000 per yr. During the year July 1942 to July 1943 the cost of operation was $311,576, of which 13 per cent was labor, 17 per cent was electric power consumption for fan operation, 3 per cent was condenser water cost, 13 per cent was compressor electric cost, 28 per cent was steam cost, 2 per cent was circulating water pumping cost, and 24 per cent was depreciation cost. This operating cost amounted to roughly 30c per sq ft per yr, or $36.70 per operating hour, or on the basis of 3000 employees per shift, 1.3c per employee per hour per shift. From this cost must be subtracted the saving resulting from the difference in heating cost as a result of having no glass exposure and no crack area. This saving is often as much as 15 per cent of the total year's heating bill.

Air Conditioning Questionnaire

However, until June 1944 the Allison Div. had no estimate of how much the use of air conditioning had benefited the manufacture of its particular product or what the reaction of its executives was. A questionnaire was therefore prepared and circulated to division heads, general foremen, and foremen. The questionnaire read as follows:

INTER-OFFICE MEMO
June 12, 1944

TO ALL SUPERVISION:

In order to help answer the many questions asked the plant engineering department by other companies and other divisions of General Motors about air conditioning and its effect on production, we have prepared the following questionnaire which we request you to answer.

We want to get a cross-section of the attitude of the employees of Allison toward air conditioning and rather than try to contact each employee, we thought that the foreman or supervisor would be in a position to know whether or not his employees like to work in an air conditioned plant and also how air conditioning (control of temperature, humidity, and dirt) affects his production.

In weighing the facts in answering the questions, please consider only the manufacturing area (machining, assembly, etc.), and not the office area.

Thanks.—F. G. TYKLE, Plant Engineer.

QUESTIONNAIRE

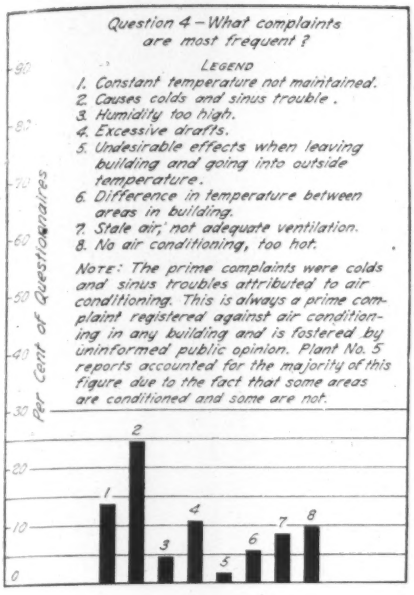
1. What is your opinion of the general employee reaction to air conditioning?
   Favorable ..... Unfavorable .....
2. How, in your opinion, does air conditioning affect or improve the following:

	None	Some	Much	Very Much
a. Employee health?	.....	.....	.....	.....
b. Employee morale?	.....	.....	.....	.....
c. Employee efficiency (quality and quantity)?	.....	.....	.....	.....
d. Employee job satisfaction and attraction?	.....	.....	.....	.....
e. Reduction in absenteeism?	.....	.....	.....	.....
f. Reduction in employee turnover?	.....	.....	.....	.....
g. Decrease in amount of building maintenance due to control of dust and dirt?	.....	.....	.....	.....

3. Do you receive many complaints on air conditioning? Yes..... No.....
4. What complaints are most frequent?.....
.....
5. What would you suggest in the way of improvements in the present air conditioning system as it affects your department?.....
6. Do you feel that buildings similar to Allison plants Nos. 3 and 5 with air conditioning are a definite improvement over buildings of conventional design with which you have had experience? Yes..... No.....
7. Would you suggest air conditioning to be installed in any future buildings that Allison might erect? Yes..... No.....
8. How much (if any) increase in scrap would you expect above what you now have, if the conditioning system were not installed?..... Base your answer upon your past experience in other plants that have no conditioning and are manufacturing a similar product. (Express in percentage.)
9. Could you manufacture the Allison engine to present production schedules, tolerances, and scrap amounts if we did not have air conditioning? Yes..... No.....
10. Would you consider a cost of 1½c per hour per employee too high a cost for the results obtained by air conditioning in your department? Yes..... No.....
11. Would you rather work in an air conditioned building? Yes..... No.....

Remarks: .....
.....
.....

Signed .....
Title .....


Question 4—What complaints are most frequent?
LEGEND
1. Constant temperature not maintained.
2. Causes colds and sinus trouble.
3. Humidity too high.
4. Excessive drafts.
5. Undesirable effects when leaving building and going into outside temperature.
6. Difference in temperature between areas in building.
7. Stale air, not adequate ventilation.
8. No air conditioning, too hot.
Note: The prime complaints were colds and sinus troubles attributed to air conditioning. This is always a prime complaint registered against air conditioning in any building and is fostered by uninformed public opinion. Plant No. 5 reports accounted for the majority of this figure due to the fact that some areas are conditioned and some are not.
Per Cent of Questionnaires
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8

The questionnaire was circulated to a total of 634 members of supervision (274 in plant No. 3 and 360 in plant No. 5) representing approximately 16,000 employees. The questionnaire was presented at weekly executive training classes.

The results of the questionnaire have been plotted on graphs, which are reproduced here, showing the combined totals of plants Nos. 3 and 5. The "did not answer" percentages are not plotted.

The data prove beyond a doubt that in the opinion of the men whose responsibility it is to secure and maintain production, air conditioning definitely is necessary and more than pays its way. While it must be realized that no doubt some percentages of the answers were made on the basis of purely human comfort, the greater majority attempted to answer the questions from a production standpoint. It is especially interesting to note that as a result of the tabulation of question No. 8 an average additional cost of 10 per cent in increased scrap would result without air conditioning. This cost plus the unestimable saving in increased production more than offset the cost of air conditioning, it is felt.

All comments under the "Remarks" section of the questionnaire were assembled, and a random selection of about a third of them is given in the following paragraphs. Several worthwhile comments are noted. Naturally, individuals become very much aware of even slight temperature differences in the plants. Their remarks show definitely that they realize when a certain area is out of control due to undercapacity and overloading, and that, just a few days per season, is enough to cause criticism of the system on a general basis.

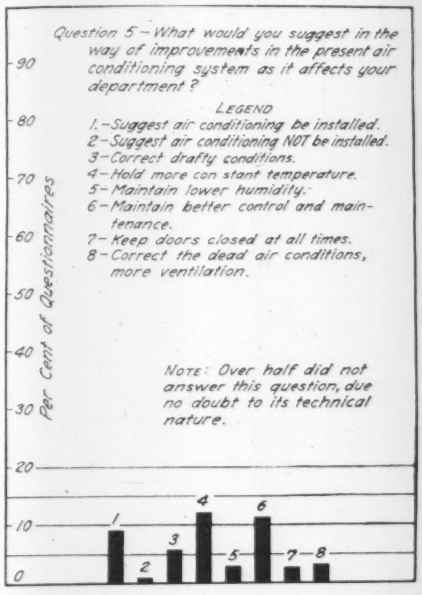
Comments of Employees About Air Conditioning

"Apparently induces some colds when first starting to work in air conditioning."

"I believe that air conditioning is very helpful cutting down re-work especially in the summer due to rust caused by perspiration."

"There seems to be a lack of oxygen in the air."

"From my own experience and from a physical standpoint, I would rather not have air conditioning."



"Office temperatures should be varied with outside temperatures with only sufficient difference to be comfortable."

"Most complaints on air conditioning result from wearing improper clothing rather than faulty functioning of the system."

"No figures to arrive at scrap cost. Fatigue point of employees would be much superior. Fatigue definitely contributes to scrap."

"Buildings having modern straight line production for large floor areas should be air conditioned."

"It is a definite contribution to health, morale, and general wellbeing of all employees."

"Air conditioning in general is a great thing."

"I believe the majority of complaints relative to air conditioning are mental instead of real."

"In most departments I believe air conditioning could be of help."

"Air conditioning is the only means of constant temperature, which is very essential in close precision work."

"Suggest keeping all doors closed as much as possible and all buildings at same temperature."

"One of the greatest benefits for the control of employee temperament, which seems to rise in direct proportion to uncomfortable temperatures."

"A lowering of temperature both during winter and summer would be my department's greatest improvement."

"The lack of sunlight and daylight causes most dissatisfaction and many blame air conditioning."

"Air conditioning, when applied correctly, is all right."

"I think air conditioning causes colds and does not help sinus trouble."

"I have my home air conditioned—I think it is fine."

"I think air conditioning is fine but could be improved."

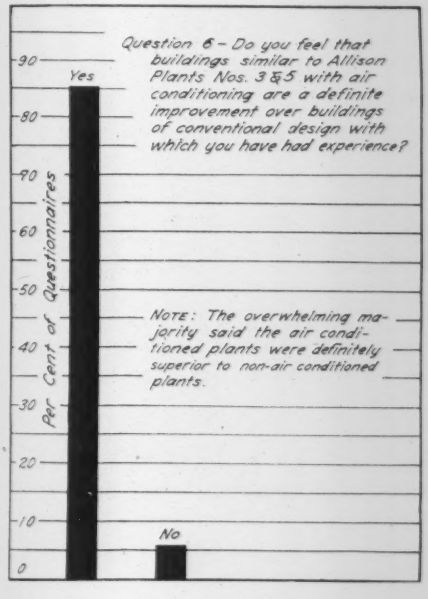
"A difference in temperature seems apparent in the various sections of the building."

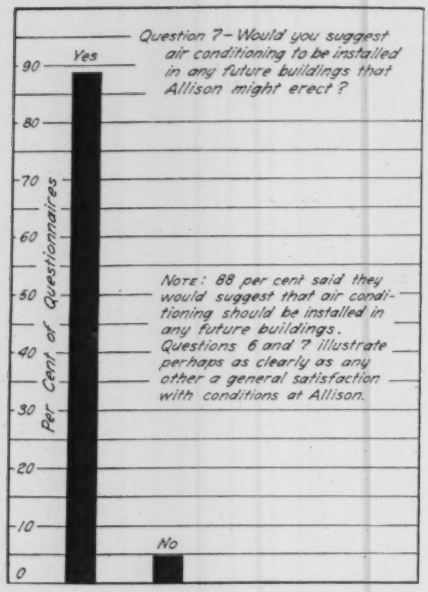
"I believe more efficient work could be done if it were cooler in my department."

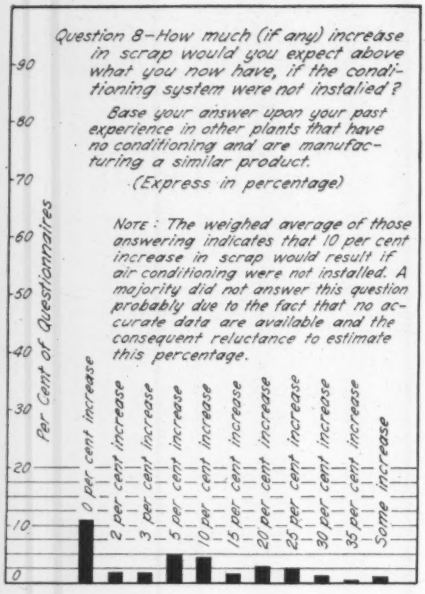
"When air conditioning is set up right, production increases but we have not reached that point with our air conditioning."

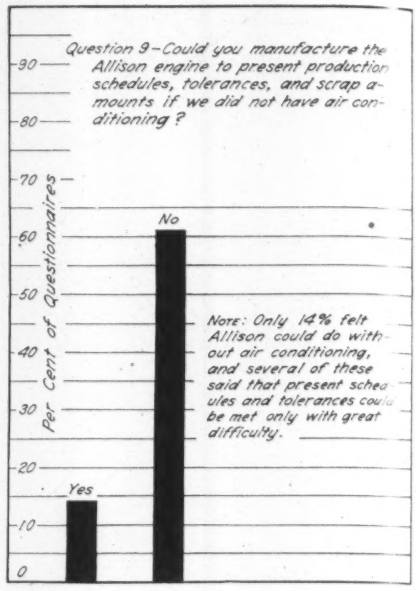
"You don't please everyone all the time. Some don't like it, but most people do."

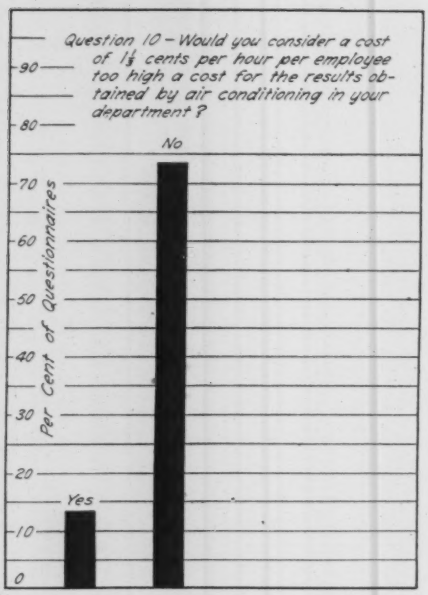
"I think an educational program of some sort would help clear up the thinking of a large group of employees, showing that controlled temperatures are not injurious, etc. I have had a number of men use air conditioning as a reason for quitting and

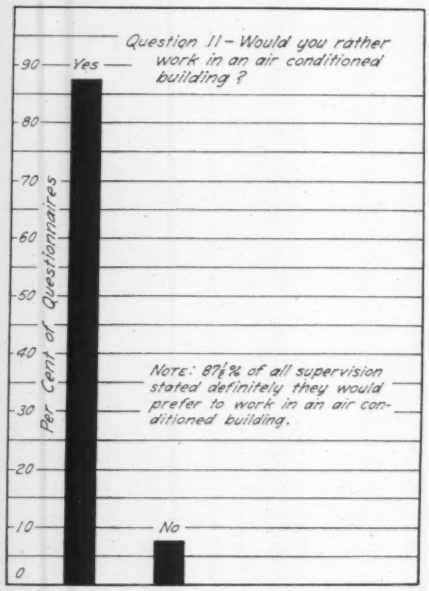

Question 6—Do you feel that buildings similar to Allison Plants Nos. 3&5 with air conditioning are a definite improvement over buildings of conventional design with which you have had experience?
Yes
No
Note: The overwhelming majority said the air conditioned plants were definitely superior to non-air conditioned plants.
Per Cent of Questionnaires
90
80
70
60
50
40
30
20
10
0


Question 7—Would you suggest air conditioning to be installed in any future buildings that Allison might erect?
Yes
No
Per Cent of Questionnaires
0
10
20
30
40
50
60
70
80
90
Note: 88 per cent said they would suggest that air conditioning should be installed in any future buildings. Questions 6 and 7 illustrate perhaps as clearly as any other a general satisfaction with conditions at Allison.


Question 8—How much (if any) increase in scrap would you expect above what you now have, if the conditioning system were not installed?
Base your answer upon your past experience in other plants that have no conditioning and are manufacturing a similar product.
(Express in percentage)
Note: The weighed average of those answering indicates that 10 per cent increase in scrap would result if air conditioning were not installed. A majority did not answer this question probably due to the fact that no accurate data are available and the consequent reluctance to estimate this percentage.
Per Cent of Questionnaires
0
10
20
30
40
50
60
70
80
90
0 per cent increase
2 per cent increase
3 per cent increase
5 per cent increase
10 per cent increase
15 per cent increase
20 per cent increase
25 per cent increase
30 per cent increase
35 per cent increase
Some increase


Question 9—Could you manufacture the Allison engine to present production schedules, tolerances, and scrap amounts if we did not have air conditioning?
No
Yes
Per Cent of Questionnaires
0
10
20
30
40
50
60
70
80
90
Note: Only 14% felt Allison could do without air conditioning, and several of these said that present schedules and tolerances could be met only with great difficulty.





I have had no valid reason for changing their thinking."

"Some few do a lot of complaining, but I think that generally most employees like to work in an air conditioned space."

"It is my opinion that this is a very good condition here at Allison's."

"Motors require very little maintenance and changes due to dirt. Machines hold closer tolerances and do not have to be repaired as often."

"Some system should be devised to have the air conditioning in operation before the start of a shift after week-end shutdown or other periods when the plant is down."

"Generally air conditioning contributes to the personal comfort and mental plane of the individual very materially."

"I think we need more sunlight in my building."

"Air conditioning at Allison's is too uneven. Should be stronger in some parts of the plant."

"Feel air conditioning is a benefit to all except the few who suffer from so-called sinus trouble, but the advantage offsets the disadvantage."

"Our worst complaint in particular is the irregularity of control. Susceptibility of sinus infection."

"'It is a relief to get to work during very hot weather' is a statement often heard in hot weather."

"Without air conditioning it would be almost impossible to maintain our working tolerances and production."

"From the employee standpoint, I believe they would be better satisfied with a lower temperature; however, this might be bad from a health standpoint."

"So far as I can see, air conditioning seems to agree with most people except those affected by bronchial trouble."

"Most of the complaints are conditions which would be there whether in an air conditioned plant or not."

"Air conditioning helps a great deal in taking care of fumes."

"Air conditioning is exceptionally good in holding close tolerances on work."

"This is the first air conditioned plant I have worked in and I would hate to give it up as it is a big improvement from other plants not air conditioned. My people like it very much."

"Would rather work in an air conditioned building but would prefer admittance of outside light wherever possible."

"I feel if the volume of air moved through the plant would be increased there would be less complaints."

"I worked for 15 years in an old, conventional building and this is so far superior that I certainly would not want to go back."

Control of the Air in Industry Helps to Win the Battle of Production

SAM LEWIS' PAGE

Forced Circulation Hot Water Heating for a Building Group

ONE OF the readers of this page asks three questions with reference to a forced circulation, hot water heating system for a group of buildings:

1) Is it the practice to install a pump in the return main adjacent to the boiler or heater, to overcome the friction head in the trunk mains, and to create flow in these mains; and to install a pump and a thermostat in each of the several buildings to control the temperature individually?
2) Are the trunk mains usually designed with direct returns rather than with reverse returns?
3) Can each building be heated with a one pipe system?

Mechanically circulated hot water is so flexible and elastic that there are no very sharply defined practices.

Answering the first question, if the plant is one having several very large structures (for example, such as a group of college academic buildings with separate dormitories, gymnasium, auditorium, etc.) that may be occupied intensively at varying hours, a desirable scheme should include ability to circulate the hot water to each building at different temperatures at the same time. In such a case a separate electric pump in each building may well be justified in addition to the central pump at the boiler plant.

Such a system might be designed to circulate water at some standard temperature through the underground mains ready for service into each building. In each building there would be a separate auxiliary pump and a separate water mixing valve that in response to an outdoor thermostat would proportion the locally recirculated relatively cool water with new hot water from the central plant to maintain the desired individual temperature. The local pump would operate continuously. The water temperature in each building might vary anywhere from 100 to, say, 220 F, and if the heat transmitters in the building are correctly proportioned and if the building is fairly compact, excellent average temperature control would be achieved.

In one very large housing project that has been in successful operation through several winters, the water pumps are at the boiler house, and in each building or group of houses there is a special throttling valve in the flow main. This valve permits only sufficient water to pass as is necessary to develop enough pressure to overcome the friction in the local system, regardless of variations in the pressure differential that may obtain in the underground mains. This scheme in a great measure accomplishes the results that would be attained by a separate local pump.

Automatic Temperature Control

In another very large hot water heating system, the various departments have individual automatic temperature control from thermostats. If one department becomes too warm the thermostat throttles the water in the branch main or in the individual heat transmitters for that department, reducing correspondingly the demand on the central station mains—thereby increasing the available pressure and accelerating the rate of water flow in the remaining departments. An interesting phenomenon inherent to forced circulation, hot water heating is the fact that the temperature drop and rate of flow do not coincide. As an extreme example, if the temperature of the air around a heat transmitter is 100 F and if the water enters the transmitter at 100 F there will be no heat transfer from water to air no matter how much water is pumped through the device.

The principal governing factor, of course, is the difference in temperature between the average or mean air and the mean water. The design temperature drop of the water at each transmitter may be any reasonable amount, averaging about 20 F but frequently 30 F.

Because the hot water temperature may vary through a wide range—this range being one of its prime advantages—great caution is recommended about using thermally circulating convectors such as are popular with steam heating. With an assured minimum steam temperature of 212 F in such devices, the air flow over the convector in rooms at 70 F will be reasonably dependable. If, however, the mean convector temperature is 165 F, as it frequently is with hot water, the reduced difference between the average air temperature and the average water temperature leads to a much reduced heat tranfer.

As to our reader's second ques-

IN THIS regular feature — a page more or less in length — informal comment on heating, piping, and air conditioning problems and their solutions is given — at the request of the editors — by Samuel R. Lewis, consulting engineer, and a member of HPAC's board of consulting and contributing editors. This month, he answers three questions from a reader about installing pumps and controls for a forced circulation, hot water heating system for a group of buildings, design of the trunk mains, and the use of one pipe systems in the various buildings of the group.

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tion, there is no evidence that the trunk mains usually are designed with direct returns rather than with reversed returns. We have designed and installed and observed operation of both schemes. The reversed return is easier to design, but is not by any means necessary.

With a reversed return there is generally more piping and labor required than with a direct return since the supply main or the return main, one or the other, must run some distance from the heater before the branches commence. The fundamental characteristic of a reversed return system is that each drop of water going to a heat transmitter from the heater travels a distance along the piping equal to that traveled by the water that serves every other heat transmitter. Thus, the heat transmitter with the longest return has the shortest supply.

In reply to the third question, each building definitely can be heated with a one pipe system. We have had experience with large apartment house type buildings served from central underground double pipe systems but using single pipe branch mains in the buildings (even with radiators below the branch mains) and these jobs operate satisfactorily.

POSTWAR CONSTRUCTION COSTS TO BE HIGHER THAN PREWAR, STUDY INDICATES

Several factors appear to point to rising construction costs and to a generally higher price level for the postwar period as compared with prewar; however, postwar inflation on the scale that obtained in 1919 and 1920 seems unlikely. These observations are made by Thomas S. Holden, president of F. W. Dodge Corp., in a study on postwar prices published by his organization.

A study of price behavior before, during, and after World War I and before and during the present conflict points specifically to three factors brought into play by both wars which spell rising prices after this one. Mr. Holden defines these factors as follows: (1) Wartime spending by government has spread purchasing power widely, has increased savings and the volume of money in circulation, and widened the potentialities of credit. (2) Government debt has increased and in enormously greater amount this time than in World War I. (3) Wartime limitations on civilian construction and on production of civilian goods generally have built up enormous potential demands.

These three factors came into play during both wars, but there exist today certain differences on the side of curbing inflationary tendencies in the postwar period.

"Price controls," Mr. Holden states, "have been much more effective this time. Business executives and people generally are more keenly aware of the dangers of rapidly rising prices than they were 25 years ago. At various times in recent years they have exercised considerable self-restraint in the face of price inflation threats. The government will probably seek to avoid drastic deflation and widespread unemployment likely to result from it. Statistics on current price trends, current production, and inventories will be more widely available and more widely understood than in the years 1919 and 1920.

"The two wars we are fighting this time will not end simultaneously. There will be a partial reconversion to a peacetime economy in the period between V-E day and V-J day and gradual, rather than sudden, removal of wartime controls. Government must procure adequate materials to finish the fight against Japan, to support armies of occupation and possibly to aid in some measure reconstruction of devastated countries.

"Productivity of American industry and its adaptability to quick shifts in production schedules are much greater than in World War I.

"These differences are on the side of curbing inflationary tendencies in the postwar period. Actual price behavior will depend in large part upon the behavior of the spending public. An early spending spree could run prices up very rapidly.

"Nevertheless, postwar behavior of prices in general, and of construction costs in particular, will be of vital importance to early and sustained revival of construction activity. The situation will call for wise policies and reasonable self-restraint on the part of producers and distributors of materials and equipment and of skilled building labor."

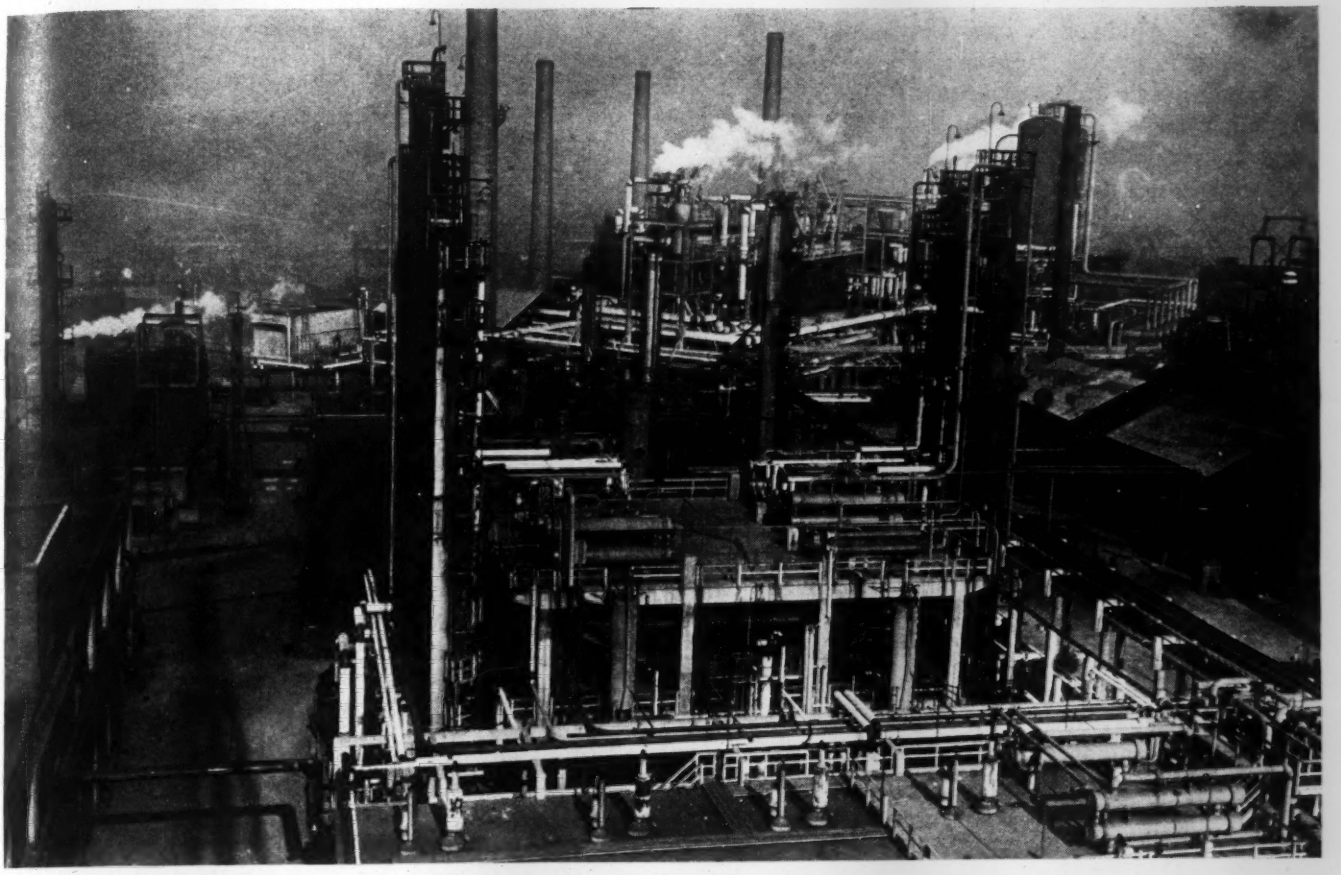
FIGHT INFANTILE PARALYSIS!

Millions of individual dimes and dollars, contributed by almost 50,000,000 Americans to the 1944 "March of Dimes," are now at work proving the essential humanity of the American way of doing things. The combined power of these dimes is giving children all over the country in areas invaded by infantile paralysis the best care that medical science offers today.

The 1944 casualty list numbered thousands of cases. Now more dimes and dollars are needed to provide continued treatment for these victims. They must furnish a bulwark of defense against the 1945 invasion of this enigmatic enemy as well as continue the scientific search to find the means of whipping it.

There is no way to determine where poliomyelitis will strike in 1945. It may be in your community. Provide for the best methods of treatment and emergency aid for yourself and your neighbors by contributing to the 1945 "March of Dimes," January 14-31. Fifty per cent of your contribution will be on hand in your county to combat this disease; the other half will be working to further the National Foundation's program of research, epidemic aid, and education. Keep America strong!

BLUEPRINT FOR TOMORROW NOW!



This picture shows the gas plants in the foreground with the cracking and treating units in the center background, and gives a good overall view. Two of the cracking cases may be seen to the right of the stack in the center of the picture

Extensive Piping Systems Needed for the Production of Aviation Gasoline

Norman S. Bosworth Describes Features of Piping Design and Materials Selection for a New Plant

THE SOHIO aviation gasoline plant at Cleveland, which went on stream last June, was designed to produce an aviation-base stock from a gas-oil charge. Briefly, the plant consists of a six-case Houdry catalytic cracking unit, a three-case Houdry catalytic treating unit, and a gas recovery and stabilization unit for each.

The charge stock is sent through a series of heat exchangers to the cracking heater, and thence to the tar separator, where heavy products which are not readily vaporized are removed. Vapors from the tar separator are fed, together with a predetermined amount of superheated steam, to the six Houdry catalytic cracking cases. The cracked vapors enter a fractionating tower where the various fractions are separated and drawn off. The overhead product, consisting of raw distillate and gas, is sent through the gas plant, where by compression and absorption recovery of valuable products from the gases is effected, and a stabilized first-pass gasoline is prepared. The resulting distillate is passed through the treating unit where it is again heated and fed to the three Houdry catalytic treating cases. Vapors from the treating cases are separated into their various fractions in the treater fractionating tower. The overhead products from this tower are sent to the gas plant where the gases are compressed, and after passing through an absorption process, the recovered distillate is stabilized and forms the aviation-base stock.

During the process outlined, a number of valuable products are recovered, among them being a butane-butene cut for alkylate feed, iso-pentane, solvent naphtha, light and heavy cycle gas oils, and fuel oil.

Materials Restrictions Complicate the Piping Design

To design and lay out the various piping systems peculiar to an aviation gasoline plant, it must be recognized that while the basic design has become pretty much standardized over a period of years, each individual installation presents its problem in layout and selection of materials due to physical arrange-

PIPING IS "industry's greatest transportation system," and many modern manufacturing processes depend upon the right piping design, correct materials selection, and carefully worked out piping details. Perhaps no better evidence of this could be cited than the production of aviation gasoline, the piping for which is the subject here. The author—materials engineer with E. B. Badger & Sons Co., designers and constructors of the Sohio aviation gasoline plant in Cleveland, which went on stream last June—reviews the selection of pipe, valves, and fittings and discusses many of the interesting features of the piping installations. Engineers and contractors concerned with piping for all sorts of industrial processes will find much of value in this very excellent and thorough article.

●

ment, geographic location, type of charge stock to be processed, and in many cases a desire on the part of the owner to conform, so far as is practical, to his plant standards.

Since the requirements of a nation at war have placed restrictions on the use of certain materials, the problem of design has become more complex. Materials which were previously chosen because of their known properties to combat corrosion or erosion, withstand high temperatures and pressures, or otherwise contribute to the life and safety of the plant are no longer available in sufficient quantity to permit their general usage. Thus, the problem becomes one of confining the use of these restricted materials to certain vital parts of the installation or finding an acceptable substitute.

American industry, accustomed over a long period of years to having its choice of the best in materials, views with suspicion and justifiable concern any mention of a substitution, and as a result, extreme caution must be used in the choice of materials to be certain that the selection of available material in no way impairs the overall efficiency or reliability of the plant. The more liberal pressure-temperature ratings for piping materials allowed under the ASA American War Standards, and the fact that maximum allowable working stresses for steel pipe have been increased over the very conservative pre-war rating, affords some relief but at the same time nullifies many rule-of-thumb standards, thereby forcing the designer to analyze carefully each condition.

The preceding statements are intended to set forth the conditions existing when the piping specifications for this project were written and actual work was started in the engineering department.

The piping material specification of Fig. 1, together with the key which accompanies it, indicates the types of piping material used for the various services involved.*

The underground piping systems are, with one exception, the conventional types found in almost any industrial plant, and thus do not warrant a lengthy discussion.

Piping for the cooling water system, operating at 50 psi, is made up of cast iron bell and spigot pipe, class B or class 150, tar coated, for all sizes 3 in. and above, and schedule 40 seamless steel pipe coated with asphaltum for sizes below 3 in.

Valves are standard IBBM gates and checks, and the screwed fittings for steel pipe are 300 lb malleable iron.

Piping for the sewers and drains is cast iron soil pipe for all lines 6 in. and below, and cast iron bell and spigot pipe, class B, for sizes

PIPING MATERIAL SPECIFICATION

FIG. 1

MATERIAL \ SERVICE	OIL-OIL VAPOR-GAS. MAX. PRESS. 150# MAX. TEMP. 450°F.	OIL-OIL VAPOR. MAX. PRESS. 300# MAX. TEMP. 600°F.	OIL-OIL VAPOR. MAX. PRESS. 300# TEMP. 600°F. to 1000°F.	OIL-OIL VAPOR. MAX. PRESS. 600# MAX. TEMP. 1000°F.	EXH. STEAM @ 50# GAUGE STEAM CONDENSATE	LIVE STEAM. MAX. PRESS. 150# MAX. TEMP. 450°F.	LIVE STEAM. MAX. PRESS. 150# TEMP. 450°F. to 900°F.	LIVE STEAM. MAX. PRESS. 300# MAX. TEMP. 750°F.	HOT AIR. MAX. PRESS. 65# MAX. TEMP. 950°F	MOLTEN SALT. MAX. TEMP. 860°F.	WATER AND AIR MAX. PRESS. 110#
PIPE - 1½" AND SMALLER	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1
2" to 6" INCL.				P1							
8" to 24" INCL.				P6							
2" to 10" INCL.	P2	P2	P2		P2	P2	P2	P1	P2	P2	P2
12" to 18" INCL.									P4		
12" to 24" INCL.	P3	P3	P3		P3	P3	P3			P3	P3
20" and 24"									P5		
26" AND LARGER	P8				P8				P7		
GATE VALVES 1½" AND SMALLER	V8	V8	V8	V8	V7	V8	V8	V8	V8	V8	V7
2" to 12" INCL.										V24	
2" & LARGER	V3	V4	V5	V6	V1	V3	V4	V6	V5		V1
14" & LARGER										V5	
GLOBE VALVES 1½" & SMALLER	V15	V15	V15	V15	V14	V15	V15	V15			V14
2" & LARGER	V10	V11	V12	V13	V9	V10	V11	V13			V9
PLUG COCKS 1½" & SMALLER	K1	K1									
2" to 6" INCL	K2	K4									
8" & LARGER	K3	K5									
CHECK VALVES 1½" & SMALLER	V23	V23	V23	V23	V22	V23	V23	V23		V23	V22
2" & LARGER	V17	V18	V19	V20	V16	V17	V18	V20	V21	V19	V16
FITTINGS 1½" & SMALLER	T1	T1	T1	T1	T8	T1	T1	T1	T1	T1	T8
2" & LARGER	T2 T3	T2 T5	T2 T6	T2 T7	T9	T2 T3	T2 T5	T2 T7	T2	T2 T6	T9
FLANGES 1½" to 24" INCL	F1	F2	F3	F4	F1	F1	F2	F4	F3	F3	F1
26" & LARGER	F5				F5				F6		
UNIONS 1½" & SMALLER	U1	U1	U1	U1	U1	U1	U1	U1	U1	U1	U1
BOLTING	B	S	S	S	B	B	S	S	S	S	B
GASKETS	G1	G1	G2	G2	G1	G1	G1	G2	G2	G2	G1

*Maximum pressures and temperatures given in Fig. 1 are individual limits and do not exist simultaneously. Allowable stresses are governed by the Code for Pressure Piping. Temperatures above 900 F occur only momentarily in lines operating at very low pressures.

above 6 in., fittings in all sizes to match the pipe.

The Oil Sewer

The exception is the so-called "oil sewer." This is a separate drainage system installed to pick up all drains where at any time oil or any oil product is drained off—for example, when tanks and towers are being drawn down and steamed out, and the resulting sludge must be disposed of.

This oil sewer has two very desirable features. It enables the refinery to recover the oil products by discharging all this drainage to an oil separator, and in case of fire, it prevents the spread of fire from one area to another through the drainage system. The latter feature is accomplished by leading the oil drains from a particular area to an area sump, which is sealed from the main line. Thus any flaming oil which might drop into a drain will be quenched at the sump and will have no chance to travel through the main and spread to another area. The method of sealing is shown in Fig. 2.

The process piping for this plant is, for the most part, an outside installation. A comparatively small part of the actual piping is under cover. The only totally enclosed spaces are the pump houses, control rooms, turbo-compressor house, and the gas compressor house. There are no unusual features in the pump house piping. The control rooms present a piping problem only from the multiplicity of small lines involved and are covered in the section on control.

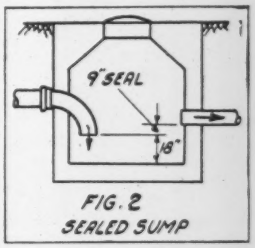


FIG. 2 SEALED SUMP

Turbo-Compressor House Piping

The turbo-compressor house does, however, present a very interesting problem. Here are found two hot gas turbine-driven turbo-compressor units, one of 40,000 cfm capacity serving the cracking unit, and one of 23,000 cfm capacity serving the treating unit. The conditions controlling the design of the piping systems for these units being the same, the discussion will be confined to the larger unit.

The inlet to the compressor is a 36 in. steel line conveying air from the filter room at atmospheric temperature. The compressor discharges air through a 30 in. steel line at a pressure of 45 psi and a temperature of 380 F. This air is discharged through an air heater, where the temperature is raised to 790 F, to the catalytic cracking cases. At periods when starting up the plant, the temperature in this line may reach a maximum of 900 F. The gas feed for the gas turbine is air containing CO_2, CO, and H_2O as discharged from the cracking cases. It is conveyed to the gas turbine inlet through a 30

KEY TO PIPING MATERIAL SPECIFICATION

Pipe

Seamless Steel Pipe to spec. API 5L Grade A.
P1—Schedule 80
P2—Schedule 40
P3—0.375 in. thick.
P4—0.250 in. thick
P5—0.3125 in. thick
P6—0.500 in. thick
Electric-Fusion-Welded Steel Pipe to spec. ASTM A155-42.
P7—0.3125 in. thick
P8—0.375 in. thick

Gate Valves 1½ In. and Smaller

V7—Wedge Gate Valve, OS&Y, IBBM, 125 lb WSP screwed ends.
V8—Wedge Gate Valve, OS&Y, FS body, 11½-13 per cent chrome trim, union bonnet, 800 lb rating at 750 F, screwed ends.

Gate Valves 2 In. and Larger

V1—Wedge Gate Valve, OS&Y, IBBM, 125 lb WSP flanged 125 lb standard.

Wedge Gate Valve OS&Y, CS 11½-13 Per Cent Chrome Trim, Flanged

Primary service pressure ratings and facings as follows:
V3—150 lb ASA raised face
V4—300 lb ASA raised face
V5—300 lb ASA ring joint face
V6—600 lb ASA ring joint face
V24—Wedge Gate Valve OS&Y CS 11½-13 per cent chrome trim, flanged 300 lb ASA ring joint face, stuffing box steam jacketed.

Globe Valves 1½ In. and Smaller

V14—Globe Valve, cast iron body, IBBM union bonnet, plug type disc. 150 lb WSP screwed ends.
V15—Globe Valve, OS&Y, CS, 11½-13 per cent chrome trim, plug type disc, union bonnet, 300 lb rating at 750 F, screwed ends.

Globe Valves 2 In. and Larger

V9—Globe Valve, OS&Y, IBBM bolted flange yoke, 125 lb WSP flanged 125 lb standard.

Globe Valve OS&Y, CS 11½-13 Per Cent Trim, Flanged

Primary service pressure ratings and facings as follows:
V10—150 lb ASA raised face
V11—300 lb ASA raised face
V12—300 lb ASA ring joint face
V13—600 lb ASA ring joint face

Plug Valves

Note: The use of plug valves is restricted to lines carrying gas or hydrocarbons having an end point of 400 F or less.
K1—300 lb Cast Carbon Steel Lubricated Plug Valve, wrench operated, screwed ends.
K2—150 lb Cast Carbon Steel Lubricated Plug Valve, wrench operated, 150 lb ASA flanged ends, raised face.
K3—150 lb Cast Carbon Steel Lubricated Plug Valve, worm gear operated, 150 lb ASA flanged ends, raised face.
K4—300 lb Cast Carbon Steel Lubricated Plug Valve, wrench operated, 300 lb ASA flanged ends, raised face.
K5—300 lb Cast Carbon Steel Lubricated Plug Valve, worm gear operated, 300 lb ASA flanged ends, raised face.

Check Valves 1½ In. and Smaller

V22—Horizontal Swing Check Valve, all iron, 125 lb WSP, screwed ends.
V23—Ball Type Check Valve FS 11½-13 per cent chrome trim, union bonnet, 600 lb rating at 900 F, screwed ends.

Check Valves 2 In. and Larger

V16—Horizontal Swing Check Valve, IBBM flanged cap, 125 lb WSP flanged, 125 lb standard.

Horizontal Swing Check Valve, CS, Flanged Cap, 11½-13 Per Cent Chrome Trim, Flanged

Primary service pressure ratings and facings as follows:
V17—150 lb ASA raised face.
V18—300 lb ASA raised face.
V19—300 lb ASA ring joint face.
V20—600 lb ASA ring joint face.
V21—Special Weld End Butterfly Valve.

Fittings 1½ In. and Smaller

T1—3000 lb Forged Carbon Steel Screwed Fittings.
T8—300 lb Malleable Iron Screwed Fittings.

Fittings 2 In. and Larger

T2—Seamless Steel Welding Fittings of pipe thickness.
T9—Cast Iron Flanged Fittings, 125 lb standard.
Cast Carbon Steel Flanged Fittings primary service pressure ratings and facings as follows:
T3—150 lb ASA raised face.
T5—300 lb ASA raised face.
T6—300 lb ASA ring joint face.
T7—600 lb ASA ring joint face.

Flanges

Forged Carbon Steel Welding Neck Flanges, ratings and facings as follows:
F1—150 lb ASA raised face.
F2—300 lb ASA raised face.
F3—300 lb ASA ring joint face.
F4—600 lb ASA ring joint face.
F5—150 lb standard raised face.
F6—300 lb special ring joint face.

Unions

U1—600 lb-2000 lb Forged Steel Ground Joint Unions, steel to steel seats.

Flange Bolting

B—Mild Steel Square Head Bolts with cold pressed hex nuts.
S—Alloy Steel Bolt Studs to National Emergency Spec. NE8739 for 1½ in. dia. and smaller, and NE8744 for larger than 1½ in. dia. with 2 cold pressed, semi-finished hex nuts of SAE 1045 ASTM A-96-33 Class I.

Gaskets

G1—Asbestos Fiber Ring Gasket, 1/16 in. thick.
G2—Armco Iron RTJ Gasket Ring of oval shape, having a Brinell hardness of 80-90.

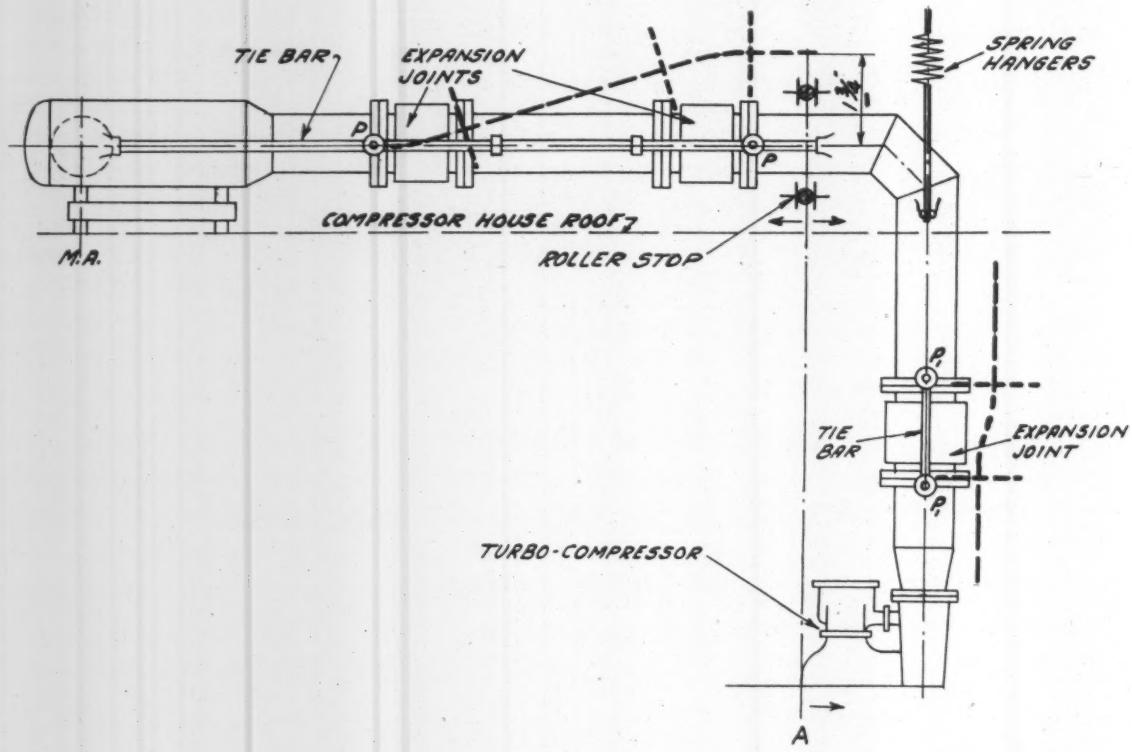


FIG. 3

in. steel line at a pressure of from 33 to 38 psi and at a temperature which may vary from 700 to 900 F. As it is imperative that no expansion thrust from the piping system be transmitted to the turbine or compressor nozzles, the support of these large pipes requires very special consideration.

Fig. 3 shows the discharge line from the compressor. The piping, as drawn, is in the cold position. This piping is anchored against horizontal movement by the roller stop and by the anchor at *M.A.* The turbo-compressor itself is anchored at point *A*. Two corrugated expansion joints are used in the horizontal line, and one in the vertical riser. The horizontal line is tied between the anchor points by two tie bars, one on each side of the line. The tie bars are pivoted at points *P*. The vertical riser has two tie bars across the expansion joint, pivoted at points P_1. The weight of the line, which is approximately 13,640 lb, is carried by two spring hangers as shown. The vertical riser expands 1¾ in. at maximum temperature, and the spring hangers are designed to carry the load without imposing weight or stress on the compressor nozzle during the entire range. As the roller stop and the anchor point of the compressor are in the same vertical plane, expansion in the horizontal direction between these points and the center line of the vertical riser is equal when the unit is at operating temperature. However, when the unit is being warmed up, the compressor, due to its mass, does not attain its maximum temperature as rapidly as the comparatively thin walled pipe line. This causes a temporary condition of misalignment and it is for this reason that the expansion joint is introduced in the riser. The tie bars allow this joint to distort in one plane only. The heavy-dotted single line in Fig. 3 shows, greatly exaggerated, the position of the center line of the riser during the warming-up period.

The roller stop, while acting as a horizontal anchor, allows free movement of the line vertically, with a minimum of friction. The two expansion joints in the horizontal portion of the line, in addition to taking up the expansion between anchor points, also distort, thus permitting the line to take the exaggerated position indicated by the heavy dotted single line. Again, the tie rods confine this distortion to one plane. As the tie rods are outside of the insulation, they are subjected to atmospheric temperature changes and consequent thermal expansion. This expansion, though slight, must be taken into account; therefore, the anchor *M.A.* is what might be termed a movable anchor, in that it is designed to permit a very slight movement in a horizontal direction. Other lines connected to the turbo-compressor unit are similarly treated.

Accurate Heat Balance Required

In order to maintain the very accurate heat balance required for proper operation of the catalytic cracking and treating cases, it is necessary to dissipate a considerable portion of the heat generated in the cases at certain cycles in the process. For this purpose, a cool-

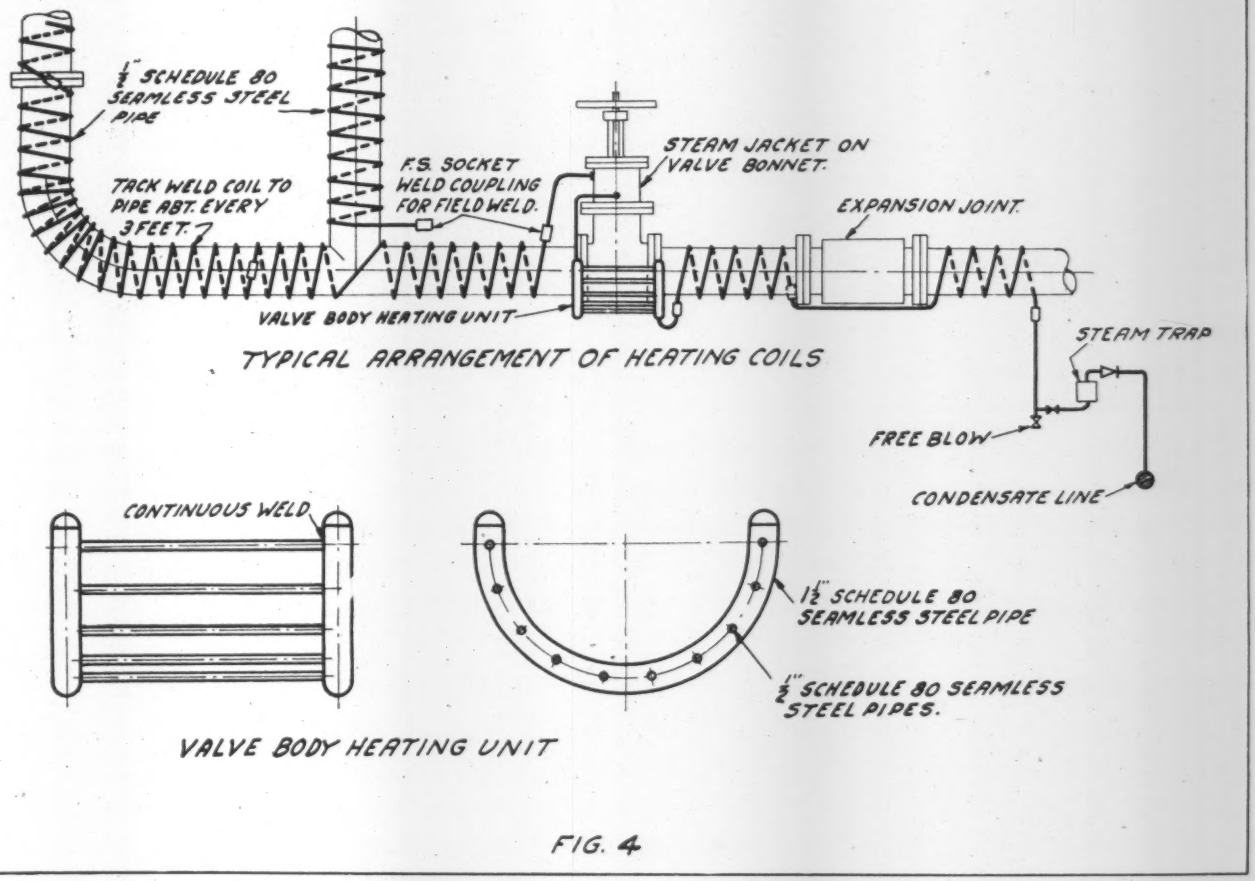

1½" SCHEDULE 80 SEAMLESS STEEL PIPE
TACK WELD COIL TO PIPE ABT. EVERY 3 FEET.
F.S. SOCKET WELD COUPLING FOR FIELD WELD.
STEAM JACKET ON VALVE BONNET.
EXPANSION JOINT.
VALVE BODY HEATING UNIT
TYPICAL ARRANGEMENT OF HEATING COILS
STEAM TRAP
FREE BLOW
CONDENSATE LINE
CONTINUOUS WELD
1½" SCHEDULE 80 SEAMLESS STEEL PIPE
1½" SCHEDULE 80 SEAMLESS STEEL PIPES.
VALVE BODY HEATING UNIT

FIG. 4

ing medium is pumped through tubes in the cases. After leaving the cases, the cooling medium is passed through two heat exchangers, in one of which the heat absorbed from the cases is utilized to generate steam, and in the other to heat the air used in the process. The cooling medium employed is "heat transfer salt," which has a melting point of about 280 F.

During periods of temporary shutdown, certain parts of this system are of necessity valved off, and thus circulation of the cooling medium is interrupted. Steps must be taken to prevent solidification of the salt during these periods. For this purpose, and for the purpose of keeping the salt in a liquid state while putting the system into operation, the situation arises where it becomes necessary to steam heat the cooling system. Saturated steam at 140 psi gage is employed for this service and Fig. 4 shows the method of piping up a typical section of the system. Steam coils are also installed in the salt storage and circulating tank. Valves above 12 in. and below 2 in. in size have steam coils wrapped around the stuffing box in place of a steam jacketed stuffing box.

Piping within the case areas is a somewhat difficult proposition from the point of design. In these areas, pipe sizes are comparatively large, temperatures are high, and space is limited. Pressure drops and rates of flow are held within very close limits, and as most of the products handled are highly volatile, pipe joints with their ever-present possibilities for leakage must be kept to the absolute minimum consistent with the feasibility of installation and maintenance. Fig. 5 shows the piping of the mains and headers for the upper level in the three-case treating unit. This will serve as a typical example of how the problems of expansion, flow, and support are handled.

Piping Within the Case Areas

It will be noted from Fig. 5 that the various mains are connected to a header for each of the three cases. The valves shown at the header are motor operated and are controlled by a cycle timer located in the control house. At different periods in the cycle, the following materials pass to or from the mains through these headers: Oil vapor at 850 F, air at 900 F, air at 800 F, and steam at 360 F. To prevent the possibility of air and oil vapors intermingling due to leakage at the motor operated valves, these valves are fitted with blocking steam connections. The headers are supported from the mains at the points marked *S*. The center of each header is tied to the bottom section of the supports, thus fixing the center and allowing the header to expand toward the ends by sliding on the joint, as indicated by elevation *XX* of the arrangement. The mains are carried on longitudinal steel beams and anchored to the beams at points marked *A*. The type of anchor is indicated by the anchor detail. Anchors are designed to support the dead load imposed on them by the weight of the piping filled with water, and to withstand the expansion thrust due to internal test pressure, which is based on 1½

times the working pressure. In the case of the anchor used as a typical detail, the dead load is 16,000 lb and the thrust is 81,500 lb. On the smaller mains where the pipe thickness permits, the saddle plate is omitted. At points marked *G* the mains are supported on guides which slide on lubrite plates. The base plates for the guides have slotted holes which permit their free movement in a longitudinal direction. The guide detail shows a typical guide construction. The guide illustrated is designed to support a dead load of 10,000 lb. The bolts are 1⅛ in. diameter and after the guide is adjusted, the heads of the bolts are welded to the supporting steel. By this method, the expansion can be distributed to, and taken up by, the expansion joints located between the anchor points. The guides prevent any possibility of side thrust on the joints. The expansion joints are of the equalizing type and are fitted with special slip joint liners to permit free flow with minimum pressure drop.

In order to reduce the size of the motor operated valves below line size for purposes of economy, and at the same time maintain minimum pressure drops, carefully designed tapered reducers are employed. Where a bend follows a reducer, a special design of tapered miter bend is used in which the pressure drops due to enlargement or contraction, depending on the direction of flow of the vapors and due to turbulence in the bend, are reduced to the lowest practical figure. The mains are pitched 1 in. in 10 ft in the direction of flow to assure proper drainage of the lines. The special miter elbows and bends serve to eliminate pipe joints and to save space.

The arrangements for the lower level piping are very similar, and the arrangements for both lower and upper levels in the six-case cracking units are also similar except for the fact that in this unit each header serves two cases, connections being taken off at each end of the header.

The Yard Piping

Yard piping, a term which is all-inclusive and takes in all piping not definitely included in a particular unit of the plant, comprises a layout whereby such factors as roadway clearance, utilization of existing steel for support purposes, proper sequence of lines with respect to entering or leaving the pipe bank, and many other similar factors have to receive consideration. The main banks of piping connecting one unit with another and including steam, exhaust, water, and air mains are carried on reinforced concrete supports to save steel and the piping is arranged so that the bottoms of all lines for a given level are at the same elevation and rest on a common support. In general, roadway clearance is established at 20 ft in trucking areas. Pipe loops take care of expansion of hot lines. Pipe supports are spaced 20 ft maximum. Lines 2 in. and above are flanged at about 40 ft intervals for ease of installation and maintenance. Welding fittings are used instead of bends for the bulk of the piping. A part of this piping may be seen in the photograph reproduced with this article.

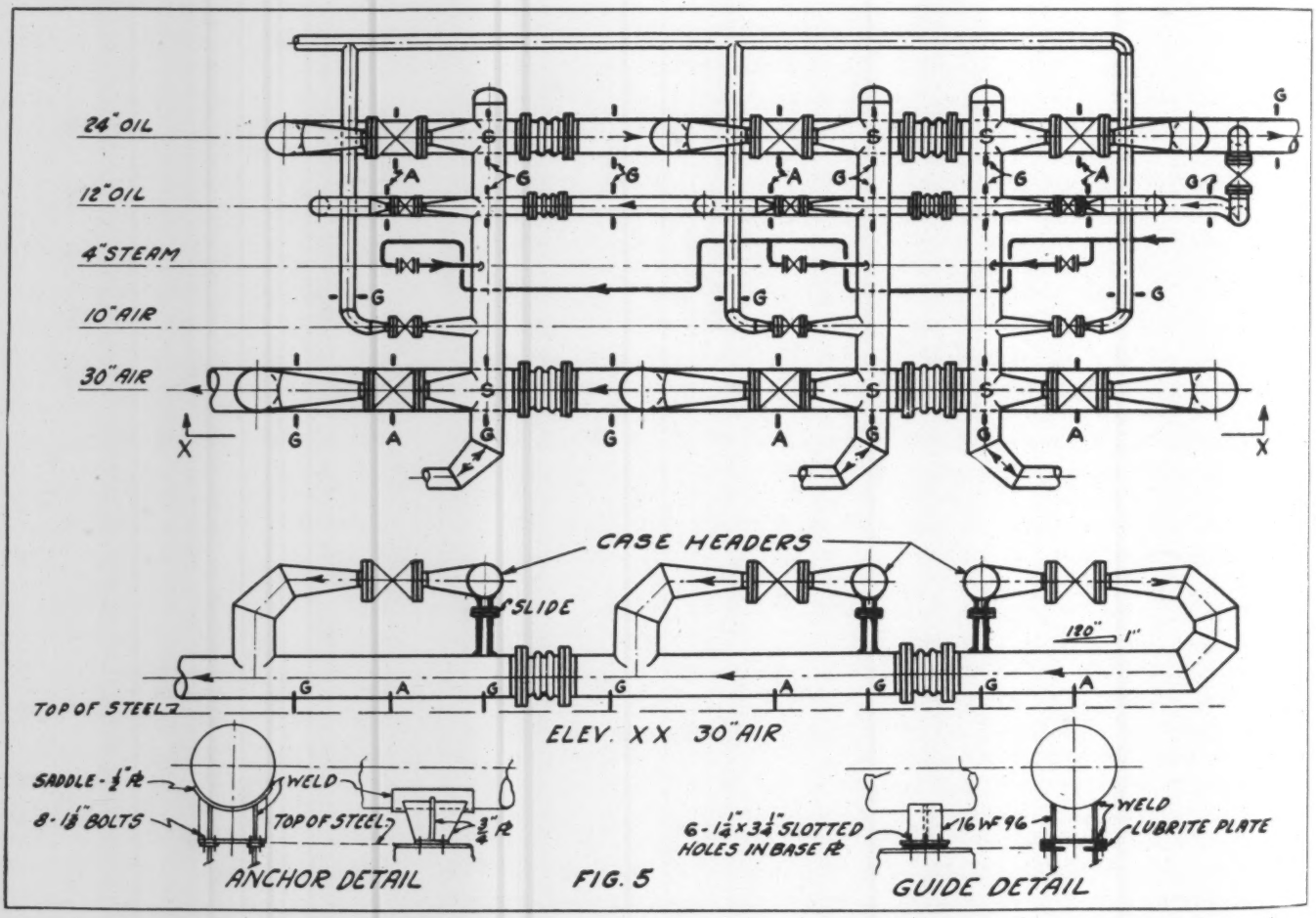


FIG. 5

Operating Control Centralized

Operating control of this plant is centralized in the control room. The instruments are mounted on steel panels which form a horseshoe-shaped control board. The cycle timer, which controls the opening and closing of the motor operated valves for the operation of the cracking and treating cases, is in the center of the control board. A flow diagram, painted in various colors to indicate the flow of vapors to and from the cases, is above the cycle timer. This diagram shows the case header piping and motor operated valves which are represented by red and green bullseye lights. This tells the operator at a glance just which valves are open or closed and which cases are on stream.

Pressure and flow indicators and recorders of the pneumatic type are connected by thousands of feet of ¼ in. copper clad tubing to the various transmitters or control valves. By means of pneumatic transmission, oil vapors are excluded from the control room. Where temperatures are to be indicated or recorded, electric pyrometers, connected to the source of heat measurement by thermocouple wire, are mounted on the board. This thermocouple wire is carried in conduit, and the conduits together with the pneumatic transmission lines are supported by means of a system of troughs starting in back of the board in the control house and extending to every part of the plant where control is required. Over 6½ miles of copper clad tubing is required for the pneumatic transmission piping.

An idea of the magnitude of this entire installation may be obtained from an analysis of the weights of some of the materials entering into the piping systems. The following weights are approximate but fairly accurate: pipe, 1085 tons; cast steel valves, 91 tons; forged steel valves, 15 tons; cast steel fittings, 2 tons; forged steel fittings, 8 tons; steel flanges, 95 tons; welding fittings, 41 tons; alloy studs, 24 tons; mild steel bolts, 6 tons; iron valves, 19 tons; iron fittings above ground, 11½ tons.

Somewhat over 5800 valves are required for control of this plant exclusive of those motor or pneumatically operated. Each one of these valves serves a definite purpose. Each one must be accessible to an operator.

This article touches only a few of the many problems which have to be solved in connection with a project of this nature. These few have been selected because of their unusual nature and the special treatment they have been given.

ESTIMATING AND CONTROLLING HEATING FUEL REQUIREMENTS

THE EDITOR—

Active interest in proper utilization of heating plant fuel promises continued improvement in the degree of conservation achieved. Hence, discussion of individual aids can materially assist the program and the choice of the aid best suited to the respective site conditions.

Richard E. Biller, in his comments on page 628 of the November HPAC, apparently feels that efficiency of estimating fuel requirements and combustion efficiency with the writer's chart, published in the October HPAC, is in some manner diminished by (1) employing the calculated heat loss of the structure served and (2) consideration of design temperature for a given locality. In deference to his objection, his further review will show that the effect of design outside temperature disappears from the chart values. The calculated maximum hourly heat load does rest heavily upon the design temperature difference but the load for 24 such hours, divided by the same temperature difference, right or wrong, yields daily load per degree without much question.

Not too long ago, radiators and furnaces were customarily sized without much regard for the kind and extent of exposure involved; and we also got by somehow in the absence of nicely regular red lines on CO_2 charts. If we have learned well since then, however, our calculated heat loads should now be correspondingly better than mere "guesstimates." Under practical conditions the same heat loads used for proper allocations or checking of heat service elements are employed on the chart.

This chart was originally devised for actual heat loads and for relatively new construction and in a cold climate where usually minor digressions from standard details became significant and where fuel experience records were sketchy or non-existent. However, the chart is also applicable for installations having experience records and floor area factors.

The bare fact that a particular installation required a given amount of fuel last year doesn't show whether or not the supplied heat was more or less than the heat load properly involved, nor does it show the overall efficiency at which the heat was generated. If we expect operators to exercise care in generation and utilization of heat, we should give them reasonably accurate goals and determine wherein the most conservation can be achieved.

Post engineers are collaborating enthusiastically in the conservation of fuel but last year's fuel bill doesn't show whether the heat or the fuel was wasted, nor how much; neither does the blanket floor area factor, unless the buildings and occupancies are standard throughout. Moreover, the post engineer wants to know where the trouble is, if any, *now*, and the writer's suggestion humbly offers a reasonably accurate means for spotting the real trouble, *now*. It does contemplate some calculation and skill therewith, but rough "guesstimates" of heat load seem scarcely enough for best professional cooperation with firemen trying to maintain accurate control of CO_2.—RAY A. SMALL, mechanical engineer.

Piping Is Industry's Greatest Transportation System!

Design and Control of year 'round comfort Air Conditioning Systems

CONTROL OF RELATIVE HUMIDITY IN CONDITIONED SPACES IN THE WINTER-TIME

THE BASIC principles that govern the design and control of year 'round air conditioning systems for comfort are organized and discussed in the series of articles of which this is the 11th, and which is devoted to control of relative humidity in conditioned spaces in winter. The author shows that humidification with steam provides a most satisfactory and flexible means, and that saturated steam at ordinary pressures of a few pounds gage does not appreciably change the dry bulb temperature of the air as long as the air remains unsaturated. He warns against letting the steam strike any cold surfaces before it is completely mixed with the air, and suggests an evaporator such as is shown in Fig. 31 for supplying steam for humidification. A table of highest recommended relative humidities for buildings with single glass or double glass windows is presented, and control of humidification is given attention. The author is professor of mechanical engineering at the Illinois Institute of Technology, Chicago, and a practising consulting engineer. He is a member of HPAC's board of consulting and contributing editors.

ALTHOUGH CONTROL of the dew point temperature of the air supply when properly installed will usually result in humidities in the conditioned spaces within the comfortable range of roughly 30 to 60 per cent, the relative humidity in the conditioned space itself can vary widely.

Thus, referring to the skeleton psychrometric chart of Fig. 29, to maintain air in the room in the exact condition represented by point *1*, the condition of the air supply would have to be in some such state like point *2* along the moisture ratio line *1-3* for the room. As the air cools from point *2* to point *1* it will surrender sufficient sensible heat to maintain the dry bulb temperature in the room and sufficient moisture to maintain the relative humidity in the room. Obviously, as the moisture and sensible heat loads change in the room, the moisture ratio line will swing to different positions. If the ratio line swings to *1-5* because of a change in the moisture load, air must be supplied in the state represented by point *4*. To maintain the temperature and humidity at the exact point, the air conditioning apparatus and the controls must be able always to provide air at a dry bulb and dew point temperature that will fall on the instantaneous ratio line.

If an air washer is used, the air obviously must always be reheated after leaving the washer. Thus, if air leaves the washer in the condition represented by, say, point *6*, the air before being supplied to the room must be reheated to point *2*, which lies on the moisture ratio line. A humidistat in the return air controlling a preheating coil can always so vary the wet bulb temperature of the air entering the washer that the air entering the reheaters will be at the correct dew point. Under humidistat control, the humidifying efficiency of the washer has no effect on the humidity control. The less efficient the washer, the higher the preheater will raise the temperature of the air entering the washer.

Unlike a dew point thermostat which, as was shown last month, cannot be used satisfactorily in conjunction with a preheating coil alone, the humidistat in the return air can be used successfully to control humidity by controlling only the steam admitted to the preheating coil. In this case also, preheating coils for freezing protection under control of only an outdoor air thermostat can raise havoc with the humidity control. It is essential that all of the heat added to the air ahead of the washer and all of the return air be under con-

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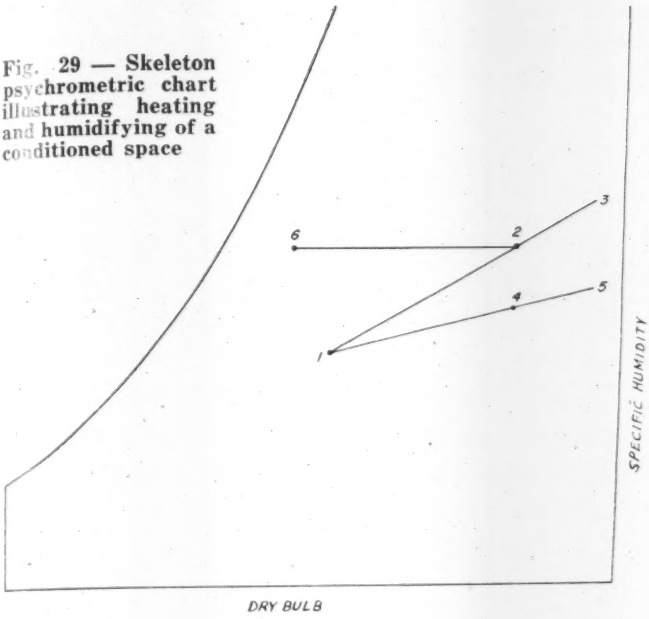


Fig. 29 — Skeleton psychrometric chart illustrating heating and humidifying of a conditioned space

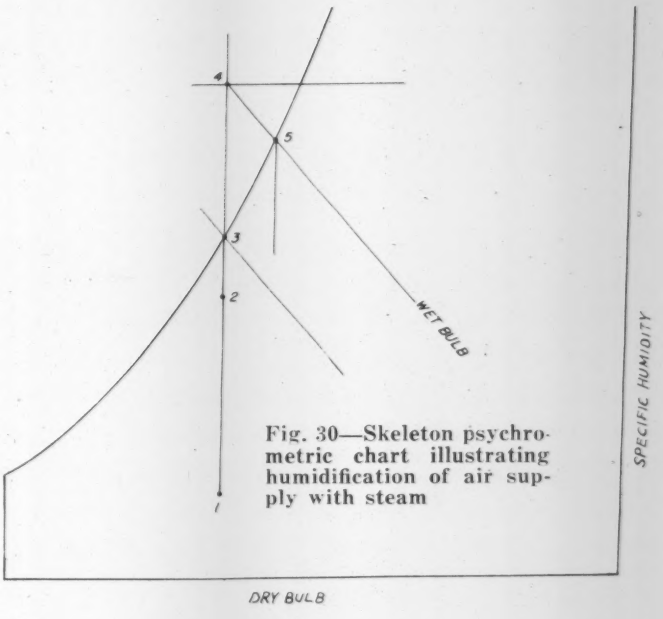


Fig. 30—Skeleton psychrometric chart illustrating humidification of air supply with steam

trol of the thermostat if satisfactory results are to be obtained.

The entire success of this control depends upon the humidistat. Satisfactory results can be obtained with a differential thermostat. If a differential thermostat is used, wicks or porous tubes are not completely satisfactory for the wet bulb as previously stated. Best results with such an instrument are obtained with a wet bulb immersed in a very small, shallow tray of water with automatic make-up. Cleanliness of the bulb and tray is, of course, essential for satisfactory results.

Humidification with Steam

Humidification with steam provides a most satisfactory and flexible means of controlling the humidity in a conditioned space. That it has not been more widely used is due primarily to misunderstanding as to how it works and to misapplication in early installations. It has been shown (see page 83 of the book Air Conditioning Analysis) that saturated steam at ordinary pressure of a few pounds gage does not appreciably change the dry bulb temperature of the air as long as the air remains unsaturated. In other words, if only sufficient moisture is added to humidify the air without creating a fog, the dry bulb temperature of the air will not change by more than a degree or two depending upon the initial heat content of the air.

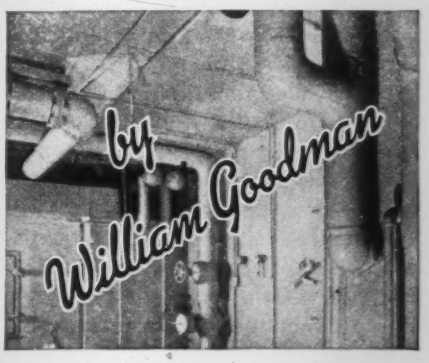
Referring to Fig. 30, suppose that air is in the condition represented by point *1*. If steam is sprayed directly into the air, the state of the air will change along an almost vertical line of dry bulb temperature like *1-3* to the final condition represented by point *2*. The dew point temperature of the air will rise markedly but the dry bulb temperature will remain practically constant. The temperature of the air will remain practically constant if only enough steam is added to raise the dew point temperature without saturating the air.

If sufficient steam is added to saturate the air and then to fog it, the condensation of the steam in the air stream will, of course, raise the temperature of the air. In this case when the air is fogged and saturated, the dry and wet bulb temperatures of the air are, of course, the same and the temperature of the air is read along the wet bulb lines extended into the fogged field of the psychrometric chart. Thus, if the air is saturated at point *3*, any further addition of steam will raise the moisture content of the air to a point like *4*. In this case the temperature of the air will rise from *3* to *5*.

On-and-off control of a steam spray generally results in fogging and in overheating of the air. For these reasons, on-and-off control is unsatisfactory. Furthermore, there will be wide fluctuations in relative humidity because the steam spray will rapidly overhumidify the conditioned space. For this reason, modulating control should always be used with a steam spray. With modulating control and a properly sized valve, fogging is hardly likely to occur. Only as much steam will be added to the air as is needed to maintain the correct relative humidity.

Don't Let Steam Strike Cold Surfaces

Another precaution to be observed with steam is to make sure that the steam does not strike any cold surfaces in the path of the air before it is completely mixed with the air and equilibrium between the steam and the air has been established. If the steam strikes cold surfaces, it will condense on them and keep these surfaces hot. The air striking these surfaces will then be heated. If the air is nearly saturated when it strikes these surfaces, there will be little evaporation. The action will be exactly the same as though the air were passing through an uncontrolled heat-



ing coil. The surfaces on which the steam is condensing will add sensible heat to the air. For this reason, a perforated insulated pipe delivering small quantities of steam at several points in the air stream will assure more rapid mixing of the steam and air than a single nozzle.

The main objection to steam heretofore has been the odor which it sometimes adds to the air. The source of this odor is generally thought to be due to compounds which are added to boiler water. Furthermore, the need for adding make-up water to the boilers to replace the steam added to the atmosphere may be objectionable. The danger of adding odorous vapors to the air and the necessity of adding make-up water to the boiler can be avoided if an evaporator of the type illustrated in Fig. 31 is used. Boiler steam supplied inside the tubes of the coil evaporates the make-up water around the outside of the coils. This evaporated moisture is then led to a perforated pipe in the path of the air stream. This type of evaporator, if properly designed, can easily be cleaned and eliminates the danger of creating an odor in the air due to the use of boiler steam.

The admission of boiler steam to the coil is controlled by means of a modulating valve controlled from a differential thermostat-humidistat in the return air. Only enough water will be evaporated into the air to maintain exactly the relative humidity required in the conditioned space.

Steam is the most flexible medium that can be used for humidifying air in winter. The principal reason for this is that if its addition to air is controlled by a modulating valve, there will be only a negligible change in the dry bulb temperature of the air. Furthermore, control complications are avoided because there are no limitations as to the dry bulb temperature or dew point temperature of the air supply. If steam is used for humidification, only a single bank of heating coils need be used. If the steam supplied to the evaporator is under modulating control, the humidifying vapor can be introduced between the heating coil and fan without danger of fogging the air supply for ordinary humidity requirements. Another advantage of the steam supply is that danger of freezing is eliminated. Finally, the expense and space requirements for steam humidification are negligible. The evaporator is relatively small because the amount of water that must be evaporated for humidification is small even in a large system.

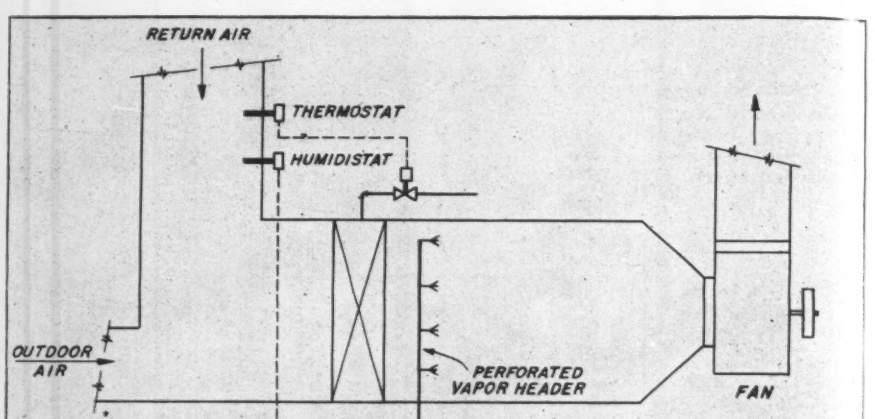


Fig. 31—To avoid spraying boiler steam into the air supply, an evaporator such as this can be used to provide water vapor for humidification

Steam humidification properly applied offers a simple and effective means of controlling the humidity in conditioned spaces and of avoiding control complications. If a steam spray is used, the humidistat must be located either in the return air or in the room, and it should preferably be of the differential bulb type.

Window Condensation

To maintain relative humidities of even 30 or 40 per cent during cold weather requires proper wall and window construction. Walls must not only be insulated, but vaporproofed to prevent the diffusion of moisture into the insulation where it is likely to condense. Windows should be double glass if the nuisance of water or frost on their surfaces is to be avoided with moderate humidities. In existing buildings, walls are rarely vaporproof even if they are insulated. Vaporproofing is, however, common practice in new buildings where humidification is to be used. Double windows are seldom used even in new construction except in a few of the more modern air conditioned buildings which have used either double glass or glass block.

In many cases, to avoid possible damage to walls and to avoid the nuisance of moisture or frost on windows during periods of cold weather, it is necessary to sacrifice relative humidity and to lower progressively the inside relative humidity as the outdoor temperature drops. This is accomplished by means of a thermostat in the outdoor air which automatically lowers the setting of the humidistat or dew point control. The following table of recommended relative humidities for an indoor temperature of 70 F is taken from curves in the ASHVE's Heating, Ventilating, Air Conditioning Guide 1944.

Outdoor Temperature F	Highest Recommended Relative Humidities Single Glass	Double Glass
—20	8	42
—10	11	46
0	15	50
10	21	55
20	28	62
30	37	68
40	48	75

Although a relative humidity of 15 per cent as recommended by the above table when the outdoor temperature is 0 F is not satisfactory from the comfort standpoint, it is superior to the relative humidities of less than 5 per cent so frequently found in heated buildings in extreme weather when no humidification whatsoever is provided.

When using an air washer for humidifying, the various humidi-

ties listed in the above table for single glass can be maintained as long as the outdoor temperature is higher than +10 F. Below an outdoor temperature of approximately 10 F, water circulation and humidification must be stopped completely and humidification cease if freezing of the air washer water is to be avoided. To maintain humidities of less than 21 per cent when the outdoor temperature is 10 F, the required circulating water temperature should be approximately 37 F. Any further reduction in humidity would obviously require a further reduction in water temperature, which is impractical if the danger of freezing the water in the washer is to be avoided.

To substantiate the preceding statements, suppose that the preheating coils ahead of the air washer are controlled by a humidistat in the return air. Assume the washer has a humidifying efficiency of 65 per cent and the water is constantly recirculated without being heated. Suppose, for the sake of simplicity, that the moisture gains and losses in the conditioned space are negligibly small, in which case the dew point temperature of the room will be substantially the same as the dew point temperature of the air supply.

Suppose that the air in the conditioned room is to be maintained at 70 F dry bulb and 21 per cent relative humidity as recommended by the above table when the outdoor dry bulb is 10 F. Suppose further that the outdoor dew point is, say, 0 F. The room condition is represented by point *3* of Fig. 32. The outdoor air has been preheated to point *1* along the line of 0 F dew point. Under these conditions, the horizontal line *3-2* must intersect the one sloping wet bulb line for which the distance *1-2* is 65 per cent of the distance *1-4*. Determined in this way, the particular wet bulb temperature to which the air will be preheated is found to be 37 F. This is, of course, also the temperature to which the circulating water will fall. If the initial dew point temperature of the air were less than 0 F, the water temperature would, of course, be somewhat higher for the same 21 per cent relative humidity.

If a low limit thermostat were installed in the circulating water to stop the circulation of water at 37 F, it would cut out when the outdoor temperature dropped to about 10 F. For any lower outdoor temperatures, no humidification of the building would be provided. However, considering the low humidities that must be maintained at low outdoor temperatures to avoid the nuisance of running water on the window surfaces, it is very probable that no great harm is done during the short spells of extremely cold weather when the washer must be cut off.

Even if the circulating water is heated by means of steam, a low limit thermostat set at approximately 37 F must be provided in the circulating water. In this case to maintain a low humidity of approximately 21 per cent when the outdoor temperature is +10 F, the temperature of the spray water must also fall to approximately 37 F if overhumidification is to be avoided.

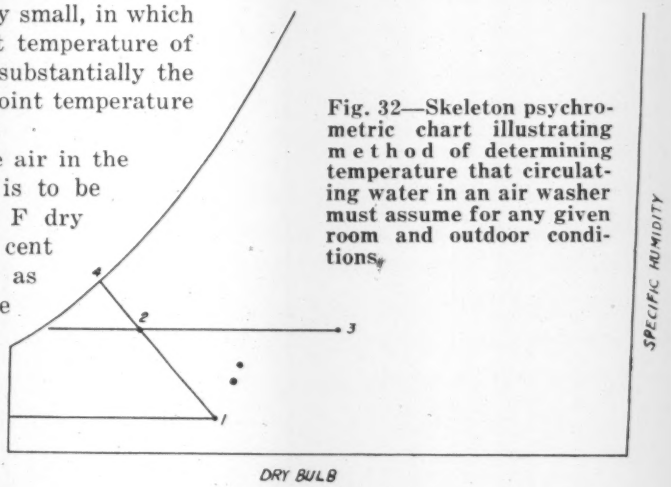


Fig. 32—Skeleton psychrometric chart illustrating method of determining temperature that circulating water in an air washer must assume for any given room and outdoor conditions.

The use of steam alone for humidification purposes does permit some humidification at any outdoor temperature inasmuch as in a correctly installed system there is no danger of freezing the perforated steam header.

DON'T WASTE FUEL!

AIR CONDITIONING UPS AIRCRAFT PRODUCTION

Two air conditioned rooms in which indoor weather is kept the same the year 'round are boosting the production of vitally needed training planes by 35 per cent at the U. S. Naval Aircraft factory, Philadelphia, according to the York Corp., whose engineers designed the equipment which makes possible continuous production operations. Installed in the fabric and dope shops of the factory, the air conditioning has saved thousands of man-hours.

In both the fabrication room, where the canvas-like covering is stretched on the frames of the aircraft, and in the dope shops where the coating is applied to the fabric, work normally is suspended when humidity rises above 68 per cent or drops below 58 per cent.

A sudden change in humidity in the fabricating operation, according to Capt. A. E. Harrison, commanding officer of the factory, meant that carefully stretched fabric would sag on the framework, making it necessary to re-cover the entire plane.

Even in winter months, weather variations shut down the operation frequently for the low humidity of cold days is as dangerous as the occasionally high humidity of rainy days. In the dope shop, for example, low humidity produced thousands of tiny cracks on the coated surface of the fabric. When this occurred, workers had to remove the whole covering or redope the surface. Captain Harrison pointed out that a repainted aircraft framework under these conditions reduces the ultimate speed of the plane by 16 mph. High humidity, on the other hand, makes drying of the doped surface virtually impossible.

Air conditioning now maintains an average temperature of 80 F and a relative humidity of 62 per cent throughout the year. The system, using centrifugal compressors, water cooled condensers, and electrostatic air cleaners, has a refrigeration capacity of 275 tons. Preheating and reheating of the air is handled by a steam plant on days when temperature must be dropped below normal to attain correct humidity.

Recent Progress in Air Sanitation

INTENSIVE STUDIES during the past year in this country and abroad have again emphasized the feasibility of eliminating airborne organisms by air filtration. The Office of the Surgeon General of the U. S. Army has announced that Dr. F. G. Blake of the Yale University School of Medicine, president of the Board for Investigation and Control of Influenza and Other Epidemic Diseases, reports encouraging progress in the trapping of pathogenic organisms on viscous coated surfaces. Details of this "germ trap," which is held as a distinct advance in the elimination of airborne organisms, are given by Dr. O. H. Robertson, Department of Medicine, University of Chicago, who heads the Commission on Airborne Infection. Dr. Robertson reports that tests conducted at Camp Carson, Colorado, and at nearby Peterson Field, Colorado Springs, covering 16,000 men, indicate that respiratory diseases were reduced approximately 28 per cent merely by oiling the floors of the barracks and by a similar treatment of the soldiers' blankets. Dr. Robertson reports that in hospital wards, oiling the floors alone cut the bacteria count from 460 per cu ft to 120 per cu ft, a decrease of 74 per cent. When in addition the bed linen was treated with oil, the bacteria count decreased 90 per cent. When the floor and blankets were oiled, the bacteria count dropped 97.2 per cent. Hospital admissions indicated that men living in the treated barracks had one-third less respiratory diseases—common colds, influenza, pneumonia, etc.—than those living in the untreated quarters. The progress of the experiments was shortened because of the obvious improvement in health conditions in the treated barracks and it was necessary to turn down requests and appeals of patients to be transferred to the oil treated barracks from the untreated quarters which served as controls in the experiment.

This oiling conception is not all together new by any means. We have for years recommended with considerable success the oiling of floors, walls, and furniture for the removal of airborne allergens in the relief of seasonal hay fever, pollen asthma, and some other allergic disorders.

Almost a quarter of a century ago the writer investigated a hay fever cure utilizing blankets and a well known liniment. The blankets treated with the liniment were hung about the patient's bed. The treatment was effective in a number of cases. We were able to establish the fact that the very strong aromatic odor of the liniment had nothing to do with the cure and that an odorless oil was just as effective in trapping airborne allergens, causative agents in these disorders.

H. C. MURPHY, vice-president of the American Air Filter Co., Inc., and a member of HPAC's board of consulting and contributing editors, reviews here some studies during the past year on eliminating airborne organisms, as well as some earlier work. Encouraging progress was made in the trapping of pathogenic organisms on viscous coated surfaces. According to a paper read some years ago before the British Institute of Mechanical Engineers, "the standard of ventilation should be one which keeps the concentration of dangerous suspended matter below a harmful point or at least as low as can be conveniently arranged."

While the use of oil coated surfaces to collect airborne organisms may represent a novel procedure to laymen in general and possibly to that part of the medical profession not actively concerned with public health work, air purification by viscous impingement is a well established technique in the field of air hygiene. Indeed, there is nothing complicated or mysterious in the creation of enclosed spaces that are relatively free from airborne organisms. For 20 years, ventilating engineers have been successfully producing such conditions under the strictest guarantees for the manufacture of pharmaceutical products, photographic gelatins, milk powders, etc., because of the obvious economies of preventing spoilage in manufactured products. Perhaps because the profit angle was not so immediately apparent we have been slow to utilize the advantages of conserving health in our factories, schools, and places of public assemblage, and except for one or two outstanding industrialists very little attention has been paid to this phase of air sanitation.

Bacteriological studies conducted by Coulter and Stone in 1937 (1)* were reported in the American Journal of Public Health. Their studies extended over a period of 18 months and covered 246 telephone booths in New York City. They found the average bacteria count in telephone booths in one of the large railroad stations was 500 per cu ft. In telephone booths supplied with filtered air in another part of the city there was found to be an average of 32 bacteria per cu ft. The investigators were inclined to attribute the difference to air filtration.

Pincus and Stern (2) reported in the same journal that investigations extending over a period of five months indicated that in a theater equipped with a ventilating system and air filters, the bacteria count averaged 3.1 bacteria per cu ft. In an unventilated theater the bacteria count averaged 13.2 bacteria per cu ft during the same period. The bacteria count in Central Park at the same time was reported as averaging 3.0 bacteria per cu ft.

Early in 1939 the public works division of the U. S. government became interested in the effectiveness of commercial air filters in removing airborne organisms from air supplied to ventilated spaces in government buildings. The problem was presented to the Division of Industrial Hygiene, National In-

*See bibliography.

stitute of Health, and J. M. Dalla Valle and Alexander Hollaender of the U. S. Public Health Service conducted investigations in this field. Their report was issued under the title of The Effectiveness of Certain Air Filters Against Bacteria (3) and indicated the efficiencies of commercial air filters against the organism B. subtilis ranged from 32 per cent plus or minus 8 per cent to 85 per cent plus or minus 9 per cent. Subsequent studies were incorporated in a publication entitled A Study of the Role of Ventilating Systems in the Transmission of Bacteria (4).

Dr. J. S. Owens, in a paper read some years ago before the British Institute of Mechanical Engineers, stated: "It is contended that the whole outlook on ventilation has been unsound and that instead of concentrating attention upon the amount of a harmless gas such as CO_2 in the air it should be devoted to the concentration of particulate matter and especially to pathogenic bacteria. Looked at from this point of view, the standard of ventilation should be one which keeps the concentration of dangerous suspended matter below a harmful point or at least as low as can be conveniently arranged." We believe that this is a well considered observation in view of the present progress in the field of air hygiene.

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1) American Journal of Public Health, October 1937. C. B. Coulter and F. M. Stone, M. D., College of Physicians and Surgeons, Columbia University.

2) Sol Pincus, Deputy Commissioner, New York Department of Health, and Arthur Stern, Superintendent, WPA Air Pollution Survey, American Journal of Public Health, April 1937.

3) Public Health Reports, Vol. 54, No. 17, April 28, 1939.

4) Public Health Reports, Vol. 55, No. 28, July 12, 1940.

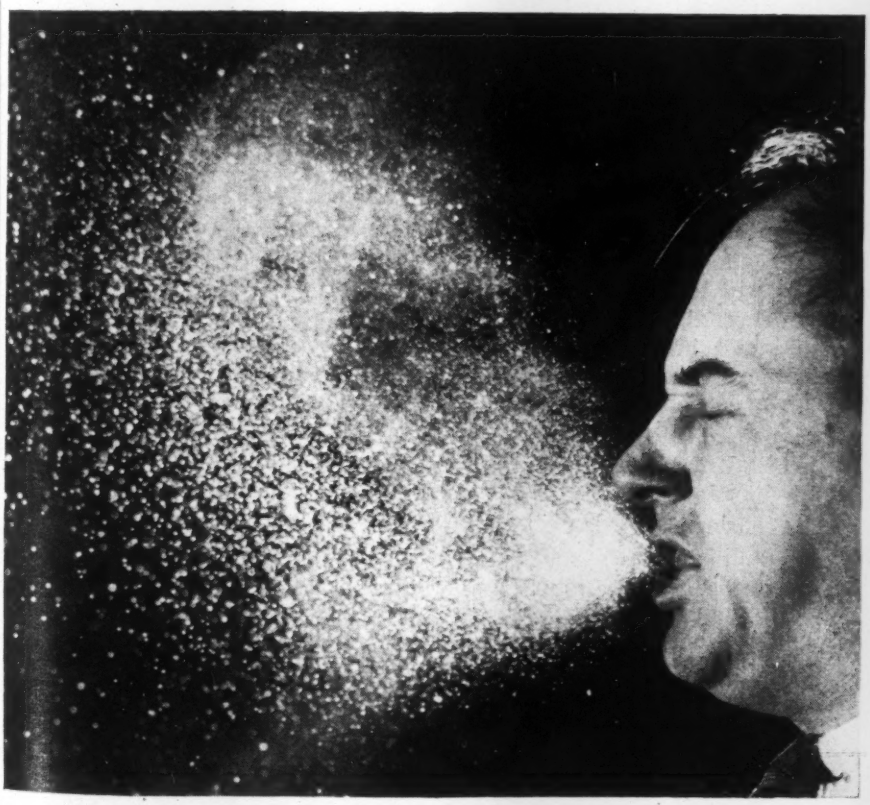

Photo showing the infection of air by sneezing, taken by Prof. M. W. Jennison, Department of Biology and Public Health, Massachusetts Institute of Technology, and illustrating graphically the expulsion of droplets in a sneeze. The picture was taken using the Edgerton technique of high speed photography, which substitutes an instantaneous flash of light for the opening and closing of a camera shutter. This stroboscopic light illumninates the object to be photographed with an intense flash of short duration. This technique "stops" objects in motion by providing a duration of flash (exposure time) so short that the object does not move any appreciable distance during exposure. The light was placed in such a position that the droplets were illuminated with a dark field effect, thereby standing out sharply even in daylight, and giving photographic images larger than actual droplet size. The time of exposure was about 1/30,000 of a second. The photograph shows a violent, unstifled sneeze. In such sneezes, the numbers of droplets expelled are in the thousands, varying with the intensity of the expiratory effort. The number of bacteria per sneeze may be in the thousands. Most droplets are under 2 mm in diameter, and many are less than 0.1 mm. The "muzzle velocity" of some droplets is as great as 150 ft per sec. Large droplets may be expelled to distances of 12 ft, but the majority do not travel more than 2 or 3 ft. The involuntary closing of the mouth near the end of a sneeze tends to form a restricted orifice, resulting in the production of more and smaller droplets. The number of droplets issuing from the nose in an unstifled sneeze is insignificant compared with the number expelled from the mouth. Cough droplets are, in general, fewer in number and larger than sneeze droplets. Some droplets fall to the ground, others evaporate, leaving their bacteria suspended in the air, through which they may be disseminated by air currents. Covering the mouth in coughing or sneezing is effective in preventing introduction of droplets into the air. Professor Jennison is co-author with H. E. Edgerton of a paper on Droplet Infection of Air, published in the Proceedings of the Society of Experimental Biology and Medicine, Vol. 43, No. 3, Mar. '40

ECPD ELECTS OFFICERS

At the 1944 annual meeting of the Engineers' Council for Professional Development, E. S. Lee, engineer of the general engineering laboratory, General Electric Co., was re-elected chairman and James W. Parker, president, general manager, and director of the Detroit Edison Co., was re-elected vice-chairman. R. L. Sackett, assistant to the secretary of the ASME, and George T. Seabury, secretary of the ASCE, were elected secretary and assistant secretary, respectively.

The ECPD is a conference of engineering organizations formed to enhance the professional status of engineers through cooperative effort. Its constituent organizations are the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, Engineering Institute of Canada, Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

Relief of High Air Temperatures in Industrial Buildings by Gravity Ventilation

By B. K. Paget*

THERE ARE CERTAIN basic principles involved in the analysis of any high temperature relief problem by gravity ventilation. The idea on which such calculations are based is a simple one: The air that enters the building has a certain heat content—more heat is added to it by the plant process which, plus the original amount, will give a final heat content for the outgoing air from which basic figures for the necessary volume can be arrived at.

In the district where the plant is located, Weather Bureau records can be used to determine what is likely to be a good design factor for the summer temperature and humidity of the outdoor air. For the particular conditions thus indicated, a psychrometric chart will give the total heat content of the air, its volume per pound, and other pertinent data.

Now, obviously, the air which moves through the building can be moved in a small or large quantity. The larger the quantity of air moved through the building, the lower will be the outgoing temperature. Rather than speculate on a final outlet temperature, using more or less air, it is sometimes better to pick a maximum permissible temperature under the roof at the entrance to the outlet openings. For instance, some plants have electric motors located in unit heaters high up in the building or may have electric motors on cranes well above the floor. Exceptionally high temperatures cannot be permitted in the neighborhood of these motors because the motors would then exceed the temperature rises for which they were designed—resulting in trouble. Where sprinkler systems are involved, there is a restriction on high temperature because of the sprinkler heads.

In general, it can be said that there is a balanced relation between a high velocity and a small volume of air used for heat removal and a lower velocity with a higher volume. It has been the writer's experience that a happy combination is achieved somewhere in the neighborhood of a 150 F outlet temperature as a maximum. This statement is not always true, but for our purposes here the statement can stand. At any rate, some final temperature can be chosen as the temperature permissible under the roof. At that final temperature there will be a new set of psychrometric data on humidity, heat content, specific volume, and specific weight of the air.

It is important to note that in most industrial high temperature relief problems no moisture is added to the ventilating air by the process. An exception is where the products of combustion of gas fired furnaces are allowed to escape into the area to be ventilated. Many plants allow the products of combustion from furnaces to go up stacks which are attached to the furnaces and the stacks are led outside the roof. Obviously, in such cases the total heat input to the building must be reduced by the amount of heat that goes up the stacks and the ventilating system will be required to handle only the remainder.

The air entering the building has a certain Btu content per lb. Each pound of air leaving the building will have a different Btu content, depending on the final temperature and humidity, but there will be more Btu per lb than were in the air when it came in. The plant superintendent should know how many Btu of gas or oil he is actually burning in the building in a 24 hr period. Knowing the Btu content of the inlet and outlet air, then the heat gain per pound of air moved through the building can be obtained by subtracting these two quantities. The next step is equally simple. The total heat put into the building represents so many Btu per hr or per min. If that figure is divided by the Btu gain per lb of air moved, the result will be the number of pounds that must be moved through the building every hour or every minute in order to remove the heat added by processing.

The next question is, What volume of air will have to be moved? The psychrometric chart will tell the cu ft per lb of air at entrance and the cu ft per lb of air at exit—the latter figure, of course, being larger due to the higher outlet temperature.

Old rule-of-thumb designers frequently used to provide air inlet openings about 1½ times larger than the air outlets; the reason for this I was never able to discover. Actually, in high temperature relief problems the size of the inlet can be smaller than the size of the outlet because, although the same number of pounds moves through each one (other than for the item of combustion air, which has to come in through the inlets and may leave either via the ventilating outlets or the stacks) the volume of the inlet pounds is appreciably smaller than the volume of the outlet poundage.

There has been much money devoted to research in the heating of domestic buildings and the ventilating of them. There has been much money spent on the study of air conditioning and its effect on the human body, but I regret to report that a minimum amount of money has been spent on investigating industrial ventilation problems. Those of us who are engaged in the industry, while we use all the skill we can command and en-

*Chief, Field Engineering Service, Allen Corp.

deavor to make precise calculations, still have to guess at some of the factors involved. Which remark brings me to a case in point, which is: "What velocity should we assume in the air inlets, and how much resistance to air flow is presented by the vena-contractae of a multitude of windows?" I know of no laboratory tests that have been conducted which answer this question. My own practice has been to assume an inlet velocity equal to the outlet velocity as determined by the calculations. In this manner I feel that the gravity action will be less handicapped by any resistance that might otherwise be caused by restricted inlet openings.

Fortunately, however, the expected velocity of the air leaving the building can be calculated in this manner:

From the psychrometric chart the lb per cu ft of air of both indoor and outdoor air can be calculated. Assuming a column of air indoors 1 sq ft in area and of a height proportional to the difference in the inlet and outlet positions, the weight of that particular column 1 ft square and X ft high can be calculated. The weight of a comparable column of outdoor air can also be calculated and the difference in the two weights obtained.

From high school days in elementary physics the formula $V\sqrt{2\,gH}$ is remembered. This formula, when it is converted to the figures applying to air handling, breaks down to $V = 4005\ \sqrt{p}$, where p equals the pressure in inches of water and V is the velocity in fpm. To convert the difference in weight of the indoor and outdoor columns of air into terms of inches of water pressure, we apply simple mathematics to determine the difference in weight per sq ft. This is then converted into lb per sq in. pressure. Now 1 lb per sq in. pressure equals 27.74 in. of water. Hence, the difference in weight of the two columns of air can be converted into inches of water pressure and when applied to the formula immediately above will give the theoretical velocity of flow for the chosen design conditions. It is not unusual to find that, if the outlet temperature has been well chosen and the heat input is sufficiently large, that an outlet velocity somewhere between 600 and 800 fpm can theoretically be expected, though we know of some jobs that are getting upward of 1000 fpm.

Comes now the question as to how much of this theoretical velocity can actually be captured and put to useful purpose. The answer as far as pure gravity equipment is concerned depends directly on the internal resistance of the outlet device, and quite naturally this figure varies considerably between the several types of competitive equipment. The outlet which would have the least resistance would be a plain hole in the roof. But because of the need of excluding rain, various baffles, overhanging roofs, and storm band arrangements mess up the 100 per cent theoretical flow obtainable. In practice, I have found actual flow values all the way between 50 and 85 per cent of the theoretical.

The writer has seen fans used on high temperature relief problems where the pressure, due to natural gravitation causes on the underside of the fan (its suction side), was greater than the fan could have produced by itself, and was greater than the pressure developed on the outside of the fan on its discharge side. In a case like this, the application of the fans was very badly handled and the engineering terrible. Actually, if each fan had been removed from the hole in the roof that it was covering, more air would have flowed out than the fans were permitting to pass. The fans actually were operating as valves so that every rotation of each blade uncovered a volume of opening which valved a certain portion of warm air. Where calculations show a condition like this will take place, it is manifestly silly to use fans because gravity ventilation will prove to be less expensive.

Ventilating devices operating by natural gravitational forces usually have a certain amount of capacity attributed to them due to both the stack effect (temperature difference and height) of the building and the wind effect of the air passing over the building. There is some justification for considering wind effect on ventilators that swing with each change in wind direction, but on *large area continuous ridge ventilation* the effect of wind varies from zero to maximum, depending on the direction in which it passes over a roof. A roof cannot be swung with the wind in order to maintain a steady suction due to wind. *In the case of high temperature relief applications to large area openings, it is the writer's contention that the effect of wind should be completely ignored.* By climbing over many roofs with test equipment and hanging in and out of many types of ventilators, I am convinced that those catalogs which show pretty arrows indicating the effect of wind as a suction factor are frequently fallacious and misleading. In my humble opinion the only proper thing to do is to ignore the wind action (*on this type of equipment*) because it is an additional variable which can well be dispensed with, the object being to reduce the variables to the lowest possible number. The ASHVE's Heating, Ventilating, Air Conditioning Guide has said for some time that the capacity of a ventilating device operating by gravity will have a total capacity which is a function both of the stack effect under the ventilating device and the velocity of the wind across the top of it. But it also states that "When the two forces are about equal in intensity and the ventilating openings are operated so as to coordinate them, the total air flow through the building is about 10 per cent greater than that produced by either force acting indepently under conditions ideal to that force. This percentage decreases rapidly as one force increases over the other and the larger force will predominate." My own experience indicates that that statement is very true, and I believe in it. Furthermore, notice the quotation says that the ventilating openings should be operated so as to coordinate them. I have never been in a plant yet that was equipped with a gravity ventilating system where anybody ever made an intelligent effort to "coordinate" ventilating openings of any type, nor do I ever expect to find such a plant. That's why I ignore wind velocity and at worst gain a 10 per cent factor of safety.

• WPB . . . OPA . . . PAW . . . Etc. •

Construction

Interpretation 11 to conservation order L-41 (construction) has been issued to clarify provisions governing building alterations that may be made in connection with installations of machinery or equipment permitted under direction 2 of the order, the WPB reported early last month.

The interpretation states that the alterations which can be made without WPB permission are only such as are directly required in connection with the installation or operation of the machinery or equipment being installed. Alterations not directly required in connection with the installation or operation may not be made under the direction.

For example, new walls or partitions may be put in where required for the operation of the machinery or equipment, but the installation of offices, office partitions, storage rooms, toilets, etc., is not permitted except by specific WPB approval.

The interpretation further points out that the direction does not limit the cost of building materials which may be used in connection with the installation of machinery or equipment to be used in a business designated on list A of controlled materials plan regulation No. 5; on schedule I or II of CMP regulation No. 5A; or in a business given priorities assistance by any P or U order for maintenance, repair or operating supplies. However, in the case of machinery or equipment to be used in any other business, the MRO symbol and an AA-5 rating may be used to get $500 worth of materials for each installation or related alteration. The amount of unrated materials which may be obtained for such an installation is not limited by the direction.

Processing or service machinery or equipment may be installed in an existing building regardless of how the equipment is obtained. However, building service equipment (plumbing, heating, lighting fixtures, and the like) may only be installed when obtained by means of an approval on a special application form such as WPB-541, WPB-542, or WPB-1319. Building service equipment not obtained through approval of a special form may not be installed under direction 2.

Plumbing and heating equipment not included on list A of limitation order L-79 (plumbing, heating and cooking equipment) is normally obtained without any application to WPB and cannot, therefore, be installed under direction 2 of order L-41.

If plumbing and heating equipment included on list A of order L-79 is to be installed in a residence, application may not be made on WPB-1319, but must be made on form WPB-2896 (application for residential construction under order L-41) and filed with the Federal Housing Administration. Approval of this housing application gives the applicant authority for the needed alterations or new construction.

Plumbing and heating equipment which cannot be obtained on a special form and therefore cannot be installed under direction 2 may be installed to the extent permitted under the annual allowance given by order L-41 or by other provisions of that order. If an installation is not permissible under L-41, an application under that order should be filed in the usual manner.

Interpretation 12 to conservation order L-41 (construction) has been issued to clarify provisions of the order that deal with the annual cost limits under which construction may be performed without WPB permission. The interpretation points out that the exemption applies only to jobs having a total cost within the annual allowance granted for the various types of construction permitted under the order.

A single job having a total cost greater than the appropriate annual allowance may not be done partly in one year and partly in another year, or partly by one owner and partly by a new owner.

Fuel Oil Ration Order

Amendment 36 to the OPA's fuel oil ration order (Rev. RO 11), effective December 6, pertains to rations for commercial motor vehicles and covers renewals, additional rations, how the ration shall be issued, etc.

Amendment 37, effective December 8, pertains to transfers of fuel oil to dealers and primary suppliers, furnishing of invoices, delivery tickets, or other customary documents of transfer, surrender of ration evidences, etc.

Amendment 38, effective December 9, extended the time for dealers to file the required statement on OPA form R-1198 from October 25 to December 31.

Amendment 39, effective December 16, provides that East Coast rations of residual oil for heating purposes again be figured on the original basis of two-thirds of normal requirements. According to OPA, this is necessary because of transportation conditions.

Amendment 40, effective December 26, permits fuel oil dealers who have one ration bank account for two or more registered establishments to apply for permission to file a consolidated "balance" statement for those places of business.

Motors

Despite heavy military demand for fractional horsepower motors, some increase in output is making it possible for manufacturers to ship several thousands each month for the most essential farm and civilian replacement use, the WPB said December 13. Repair shop owners were advised by WPB to shop around for suppliers who can fill their orders, and to urge suppliers to file an application with WPB each month for allocation of small motors.

Repairmen needing small motors for replacement in refrigerators, commercial refrigeration systems, washing machines, oil burners, coal stokers, pumps, etc., should use the AA-3 rating assigned to them by controlled materials plan regulation 9A in placing orders with motor suppliers, WPB officials said. These suppliers include washer, refrigeration or industrial machinery jobbers, electrical wholesalers, motor dealer agencies, factory branches, and mail order houses.

[*See page 226, back section, for further information*]

In order to help promote the objectives of the National Fuel Efficiency Program, conducted in cooperation with the U. S. Bureau of Mines, we have stressed in our pages during recent months that conservation of all fuels is always good business, and in wartime is a patriotic duty as well. As pointed out by a speaker at a recent engineering meeting, information on efficient utilization of fuel must be brought home "to the men on the operating floor, because it is there that the savings and economies, if any, are made." It has been the aim of the articles by Kalman Steiner published in HPAC during 1944 to condense some of the vast amount of available information on fuel technology and combustion fundamentals for the immediate use of and practical aid to operating engineers. He continues his discussion of wartime fuel efficiency this month with an article on a following page devoted to an easy-to-read, practical review of combustion fundamentals.

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When a heating or air conditioning plant is designed with a full understanding of the character of operators that will be available, with a consideration of the need of continuity of service, and with a study of the economies that determine how much the owner can afford to pay for "saving devices" —and is then put in the charge of competent, willing operators who approve the design as one that is practical from an operating standpoint—there will be no difference between design and operation, the plant will prove efficient, and the demands for conservation will be served, says John Howatt in his article this month on coordination of plant operation and design.

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Here's a "practical pointer" that saved the day at a large plant where a special copper Y fitting in a 14 in. pipe line was split by water hammer, causing a shutdown. Wire was wrapped loosely around the split fitting, and a box was built around it. Ready-mixed concrete with quick-setting cement was ordered from a nearby mixing plant and poured into the box around the fitting, the wire serving as reinforcement. The mill was running again in six hours, and the "concrete fitting" did the job for several days until a new copper fitting, with heavier walls than its predecessor, could be fabricated.

●

Too often, says K. A. Gruber in his discussion on simplifying the maintenance of air conditioning systems, air conditioning and ventilating equipment is tucked away in some inaccessible place or covered up in some manner so that it is practically impossible to give it the care it should have. He suggests a number of practical considerations to observe if installations are to be kept in the best working order.

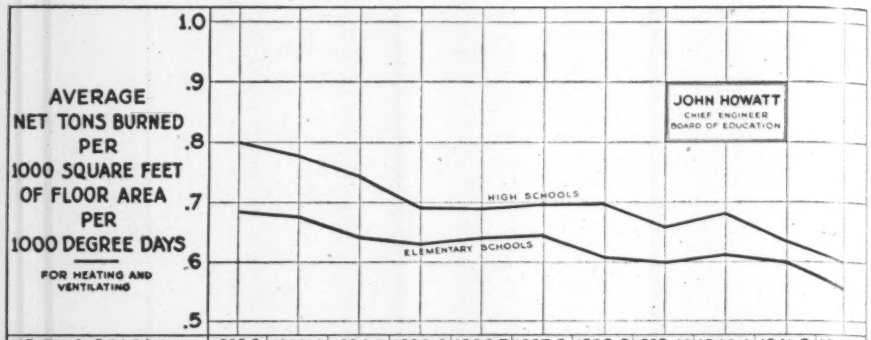
...on Operation, Maintenance, Repair, Alteration, Extension

THE DESIGN and installation of a heating, a piping, or an air conditioning system in an industrial plant or a large building is but half the story—or maybe less. The success of every system depends upon its proper operation and maintenance. In addition, as time goes on, major or minor repairs will be required, and certain parts of the system will require replacement. Besides the normal operation and maintenance necessary for the functioning of a heating, piping, or air conditioning installation, problems involving alteration or extension of the original layout undoubtedly will come up. A new process in a plant may, for example, necessitate a revision in the piping or an extension from the existing piping services. New developments in equipment or methods may make advisable a major change in a heating system serving a large building. Most plants and buildings now partially air conditioned will be extending this service to additional areas. . . . It is planned to publish regularly, under the above "Practical Pointers" heading, down-to-earth articles and comment stressing particularly the answers to some (at least) of the problems involved in operation, maintenance, repair, alteration, and extension of heating, piping, or air conditioning systems. Ultimate success with a heating, piping, or air conditioning job depends very greatly on what goes on after the original installation is completed

For Best Results, Plant Operation and Design Must Be Coordinated

By John Howatt

WHEN A heating or air conditioning plant is designed with a full understanding of the character of operators that will be available, with a consideration of the need of continuity of service, and with a study of the economies that determine how much the owner can afford to pay for "saving" devices, and is then put in the charge of competent, willing operators who approve the design as one that is practical from an operating standpoint, there will be no difference between design and operation, the plant will prove efficient, and the demands for conservation will be served, says John Howatt, in this "practical pointer" on the relationship of design and operation. Mr. Howatt, the chief engineer of the Chicago Board of Education, has also just been named its business manager. He is a member of HPAC's board of consulting and contributing editors.



HEATING SEASON		1932-3	1933-4	1934-5	1935-6	1936-7	1937-8	1938-9	1939-40	1940-1	1941-2	1942-3
DEGREE-DAYS FOR THE 8 MONTH PERIOD OCTOBER TO MAY INCLUSIVE		5972	6042	6043	6784	6219	5866	5719	6496	5849	5496	6656
TOTAL TONS OF COAL BURNED		148,511	167,157	151,256	165,285	51,594	149,069	141,891	159,175	151,070	142,539	155,579
AVERAGE NET TONS BURNED PER 1000 SQUARE FEET OF FLOOR AREA	HIGH SCHOOLS	4.8	4.7	4.5	4.7	4.3	4.1	4.0	4.3	4.0	3.5	4.0
	ELEMENTARY SCHOOLS	4.1	4.1	3.9	4.3	4.0	3.8	3.5	3.9	3.6	3.3	3.7

This chart of coal consumption in the Chicago public schools illustrates the reductions in fuel use made possible by education, creation of operator interest, and the installation of practical fuel saving equipment

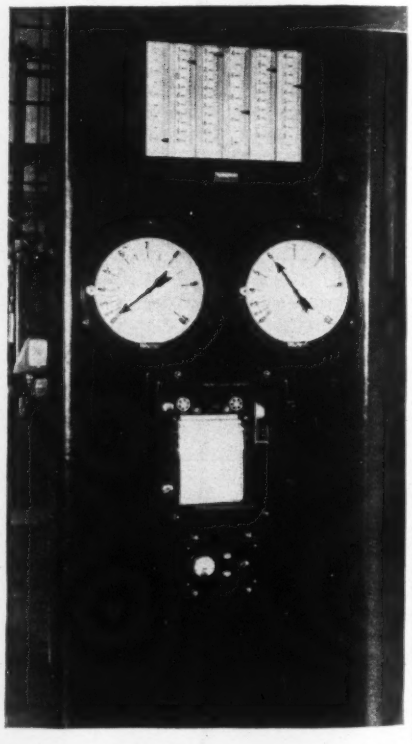
THE DIFFERENCE between the way in which heating and air conditioning plants are actually operated and the way in which the designer expected they would be operated is an example of the difference between theory and practice that has vexed those responsible for large plant operations, the designers of the plants, and frequently the manufacturers of parts of the equipment that went into the installation.

It sometimes happens that in the interest of seeming economy, a class of help is employed that is not sufficiently skilled or trained to make the most of the plant and its equipment. Anything more complex than a shovel and wheelbarrow is beyond their capacity to understand. The man with the hoe would find himself confused if put in charge of the operation of modern tractor-combine equipment on a farm. The man whose only experience with combustion control in a boiler room was limited to opening or closing the ashpit door would find himself confused in trying to operate a plant equipped with modern instruments and control devices. How much an employer can pay for plant operators depends, of course, upon how much investment is involved. Incompetent help belong to that general classification of individuals known as the "can'ts."

The writer has had experience with plant operators who were competent enough, but who were both physically and mentally indolent to a degree they have a lack of interest and an indifference that brought about that minimum of activity on their part that they could exhibit and still hold the job. These operators belong to that general class of individuals known as the "won'ts."

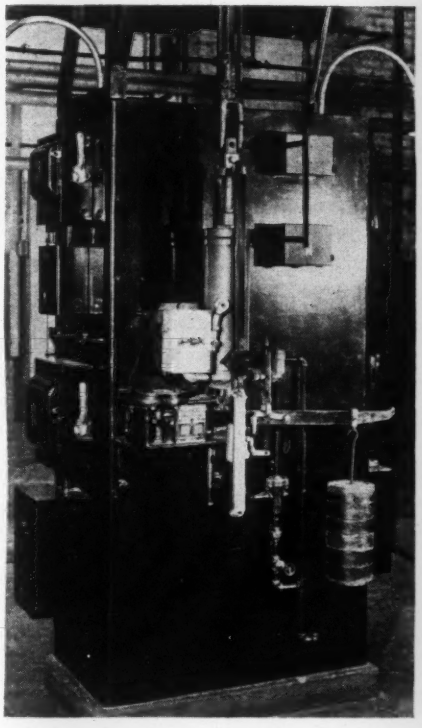
It is not infrequent to find that the engineer who designed the plant did so either without any conception of or reference to the practical operation. Too often, "supersalesmen" influence the designer and gadgets and intricate designs are worked into the installation that have no place being there. Too often, so-called economy devices

Instrument panel with draft and air pressure gage, horsepower indicator, breeching temperature recorder, CO_2 recorder and indicator. Novices cannot be helped with such instruments added to a boiler plant, but trained and interested operating personnel can

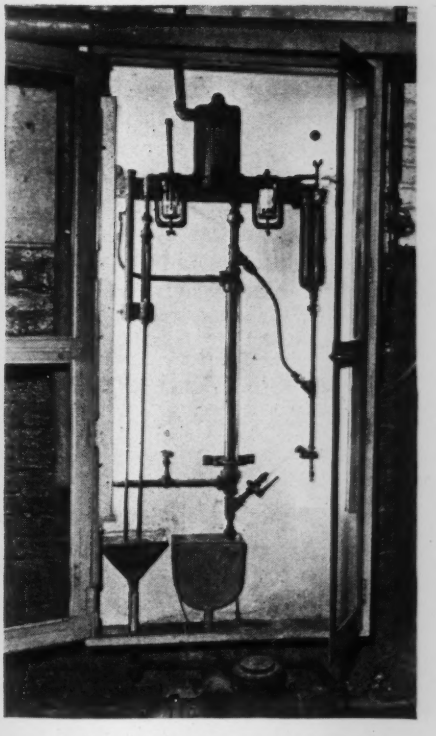


are specified and then paid for by the plant owner that cannot possibly earn their cost by savings they return in their useful life; usually, too, these devices and gadgets are the parts of the plant that require the greatest expenditure of both time and money in upkeep, operation, and maintenance. A competent and willing operator who is placed in charge of such a plant spends the first year of his service in simplifying the plant operation, not by completely adapting the operation to the gadgets but by adapting the gadgets to practical operation. This of necessity sometimes results in some of the impractical devices and designs being bypassed and kept out of use.

The need of close cooperation between the designers and those who are to be responsible for operation is thus illustrated. This lack of cooperation—in the opinion of the writer—is responsible for more design errors than any other one thing that can be named. When one man is responsible for design and another for operation, there can be a division of responsibility for results, the designer blaming the operator, and the operator the designer, for any failures. "Passing the buck" is one of our national pastimes. If those who are to operate the plants must approve the design there is no one to whom blame can be passed. The competent and willing operator belongs to the class of individuals known as the "I will's" and is one of the types that is most prized by the employer. With such an operator, the errors in the design will be corrected and the plant operation made as economical and successful as possible.



Forced draft fan control panel



CO_2 continuous analyzer

Manpower and Material Shortages

We are in a time of manpower shortage. The headlines in the newspapers keep us reminded of it and in most areas industry actually is finding difficulty in securing enough help. This has brought about a situation in labor shortage areas where manpower is spread over rather thinly and as a consequence one person is required to do so many things that some of the things that ought to be done have to be neglected. This is an emergency situation, of course, but it is one that is today affecting plant operation and maintenance. Some of the maintenance repairs and improvements that should be done in plants are having to be deferred temporarily because of lack of men and materials with which to do the desired work and some of the devices and parts of plant equipment that would normally be given close attention and that would produce efficiency and economy are of necessity neglected because of those shortages. The war is blamed for many things; sometimes it is but an excuse, but very often it is a valid reason.

THE ADVENTURES OF A POUND OF STEAM...1

By A. C. Kirkwood

STEAM HAS been described in various terms ranging from the uncomplimentary to the highly scientific, depending upon the type and extent of contact. Not long ago a young naval engineer wrote that although he had been exposed to a good deal of instruction and considerable practical experience, he still admitted that his knowledge of steam was meager. He further asked aid in understanding what happens to steam during its travels and changes of state in a plant piping system. Nice of him to open up such a broad subject, wasn't it? But perhaps some observations on happenings here and there in such a system will help him and others, too.

Steam is water vapor. It is one of the forms of substances. All substances are classified according to physical state as solid or fluid. Solids are not obviously deformed by slight external forces, and they retain their shape when unconfined. Steel is a solid. Fluids, on the other hand, will flow and will not hold their shape since they have no definite form except that imposed by the container.

Fluids can be classified as elas-

tic and inelastic. Inelastic fluids are usually considered to be liquids. The use of the term "inelastic" in this description is by poetic license. Many users of liquids at abnormally high pressures will testify that the sudden application of these high pressures will result in an elastic compression of the liquid. Nevertheless, the definition is adhered to for its relative value.

Elastic fluids are divided into gases and vapors. Both can be condensed by increase of pressure, but gases can be condensed only if the temperature is also lowered below the critical temperature. Vapors, on the other hand, can be condensed by increase of pressure alone without change of temperature.

A NAVAL officer wrote the editor recently and suggested a series of articles on what happens to a pound of steam as it travels through a piping system from its point of generation to its point of use, and Mr. Kirkwood (perhaps unwisely) agreed to write about at least some of the adventures which might be expected to befall it. In this first chapter, he establishes the character of our subject by reference to a set of steam tables. From time to time in future months, we will follow this same pound of steam through various parts of the piping system. . . . Mr. Kirkwood is associated with the Burns & McDonnell Engineering Co., consulting engineers, and is a member of HPAC's board of consulting and contributing editors.

Steam is the vaporous form of water. As such it contains considerably more internal energy than water, even though their temperatures and pressures be equal. In fact, steam at 101.74 F (one pound per square inch absolute pressure) contains more heat units or internal energy than water at the critical pressure of 3206.2 psia,* 1106 Btu as compared to 902.7 Btu. It is thus seen that steam is "agitated" water, contains so much exuberant energy that it swells well beyond the space required by the same mass of water. What are these quantities of energy that produce the transformation of state from liquid to vapor?

The heat of the liquid, water, at 212 F is 180.07 Btu. This is the condition of water at the boiling point at the atmospheric pressure of 14.696 psia. If a 1 lb mass of pure water at this condition is under study and 970.3 Btu is added, the water will be entirely evaporated without increase of temperature. The total heat content of this unit mass of steam will be 1150.4 Btu. The added 970.3 Btu is termed the total heat of evaporation. It is composed of two elements, the internal heat required to evaporate the water at constant pressure and temperature and the external work done by the steam in making room for itself against the pressure under which it was generated.

Dry and Saturated, and Wet, Steam

The foregoing comments have dealt with steam in its dry and saturated condition. Since it is free from water, it is said to be dry. It is at the same temperature as the water from which it was generated and the slightest reduction in temperature would condense it into water. Therefore, it is said to be saturated. It should be noted that change of state is actually instantaneous in relation to minute masses, individually and collectively. Commercially, this process involves a certain time lag. The instantaneous generation of steam from all the water in a boiler would accomplish no good purpose.

Should our 1 lb mass of steam be heated further and under constant pressure, it will absorb heat (energy) with a consequent rise in temperature. So to speak, its increased energy reacts like bees in a plugged hive. It requires approximately 4.4 Btu per lb of steam at the previously stated conditions to increase the steam temperature from 212 to 220 F. This process is known as superheating.

Another condition in which steam is to be found is as wet steam. In this condition, steam contains entrained moisture as droplets or mist. The proportion, by weight, of the dry and saturated vapor to the whole quantity present is termed the quality of the wet steam. It is usually expressed as a per cent. This condition presupposes a certain degree of homogeneity of moisture droplets and vapor. Moisture in true liquid state contained in a steam vessel or pipe would not contribute to the quality of the steam in that vessel or pipe.

A. P. Steam, whose adventures we will follow

The total heat content of steam is known as the enthalpy of steam. It is calculated above 32 F. The heat of the liquid is the heat content calculated to the same base, i.e., above 32 F. The addition of heat or energy to steam follows very definite laws. The extraction of the energy of steam follows the same set of laws. These can be and are set forth in detail in many fine texts, but a general summary in useful form is to be found in the Keenan and Keyes Steam Tables produced under the guidance of the American Society of Mechanical Engineers. With accurate measurement of pressure and temperature, all properties of dry and saturated or superheated steam are readily found from these tables.

So, to our young Navy friend, steam is at once a container and a ready transporter of energy. It is in a form quite useful for generation of power or for the many processes involving heating, even cooling. Comments on some phases of the methods used to generate steam and the troubles which beset its path through plant piping system will be discussed from time to time in future months.

* * * * *

One square foot of equivalent direct radiation, abbreviated "EDR," is that amount of heating surface which will give off 240 Btu per hour. The equivalent square feet of heating surface may have no direct relation to the actual surface area, according to the ASHVE Guide.

*Psia is the abbreviation for "pounds per square inch absolute."

How to Simplify Maintenance of Air Conditioning Systems

By K. A. Gruber

DUE TO THE fact that many air conditioning systems are installed as additions to already-existing premises, it has too frequently been the unfortunate habit to tuck the equipment away into one of the few remaining empty corners of the floor or building. This in turn makes it necessary to run the ducts just as inaccessibly to the points of distribution of cooled air. I am thinking here particularly of department stores, restaurants, and other places where the cooling unit, fan, and plenum chamber are hidden in storage rooms, buried under boxes, bales, and cartons, or—which is worse—stuck high up into a corner of the ceiling. Admittedly, an air conditioning system from unit to outlets is not supposed to be a work of art, but nevertheless it is an important installation without which many a business would soon be "out of business." In many cases, interior decorators feel that the air ducts should be hidden as much as possible and often build a plaster wall around them or put them into inaccessible hanging ceilings and so forth. Nothing could be more ill-advised.

The average cooling or air conditioning system will run, in my experience, for approximately two to four years without much trouble. Then the owner of the installation may notice a definite "spitting" of dust and carbon from the grilles, which is caused by accumulations of just such particles throughout the entire system. In department stores and other places of public assembly, this will cause considerable annoyance and the soiling of merchandise, etc. In addition, the efficiency of the system is being reduced which, in turn, results in higher operating costs. The maintenance engineer is faced, in many cases, with insurmountable difficulties due to the inaccessibility of the entire system. More than once have we found systems in department stores, hotels, etc., which could not be cleaned at all without causing considerable damage due to the faulty layout of the original installation.

Suggestions for Simplifying Maintenance

I would, therefore, like to make the following suggestions:

1) Unit, coils, fan, filters, and plenum chamber should be as accessible as possible—preferably in a room by themselves, to be kept in good shape through regular maintenance by skilled personnel.

2) The ducts should be accessible, not covered or hidden behind plaster constructions. Painted in the same color as their surroundings, they will be inconspicuous.

Let us now consider the problems involved in the maintenance of the system proper, assuming it is laid out and installed as suggested above. As mentioned, such systems, after a certain period of time, will fill up with dirt and dust, despite the installation of one or more banks of filters. We know of the case of a department store where in the men's wear department all shirts had to be laundered due to the dirt spread by the air conditioning system. In other stores the labor turnover was considerable because of the strain which was put on the already depleted personnel, called on to brush and clean all merchandise every morning. Besides, such accumulations of dirt are highly combustible and represent a definite fire hazard. This latter point is particularly important in factories which have air conditioning systems installed in an increasing manner to improve working conditions and in such cases as bearing manufacturer, to assure satisfactory production. In factories the above mentioned two to four year faultless operating period of the air conditioning system is almost never achieved because of the large amount of dirt, carbon, and lint usually sucked into the system. Installations in laundries, foundries, tanneries, etc., may call for attention almost every three to six months or even more frequently. The solution to this problem is to subject the entire system—from intake to outlets—to a thorough cleaning. It follows, therefore, that every part of the system should be ac-

IN THIS "open letter to builders and buyers of air conditioning systems," Mr. Gruber (secretary-treasurer of the Chemical Fireproofing Corp. of New York) gives a number of practical pointers on the installation of air conditioning and ventilating equipment to facilitate cleaning and maintenance. Too often, he says, the equipment is tucked away in some inaccessible place or covered up in some manner so that it is practically impossible to give it the care it should have. Provisions for access to ducts for cleaning them are essential, he stresses, and every fan housing should have a proper opening with a door so that the fan can be kept clean. The author has had a wide experience in the maintenance and cleaning of air conditioning and ventilating installations in plants and buildings.

Deposits of grease and oil inside fans and ducts are a fire hazard

cessible not only from the outside but also from the inside. Let us consider here every part of the system which will need cleaning and attention at regular intervals:

1) *Outdoor Air Intakes:* The intakes should be so located as to obtain the best possible air from the outside. Through the suction from the fan, paper and other larger particles will be brought into the intake. It is therefore advisable to install a medium fine mesh screen in front of the intake and inspect it regularly every second or third month.

2) *Cooling and Heating Coils* should be inspected and cleaned frequently. Dirty or rusty coils cut down immediately the efficiency of the entire system.

3) *Filters* should be checked regularly every four or five weeks according to the location of the outdoor air intake and the general working conditions.

4) *Cooling Unit:* This piece of equipment should receive the closest attention and regular inspection.

Two of the most important, and in many cases, the most neglected items are: (5) *Ducts* and (6) *The Fan.*

Access for Cleaning Ducts

A large air conditioning system involves many hundreds (or sometimes, thousands) of feet of ducts. Ducts are an ideal location for the accumulation of all kinds of dirt, oil, etc. The only way to remove that dirt is to enter the ducts with the proper tools and clean them. In order to do that it is imperative that openings be installed. Not always is it possible to remove the grilles and in many cases this would involve destroying the adjacent paint, wallpaper, or decorations. It is therefore obvious that, wherever the grilles cannot be readily removed, other access openings must be cut and the proper doors supplied. No duct should be without these doors and if they are not in existence at the time of the original installation they should be cut at the first cleaning. The distance between doors should be approximately 20 ft. All the grilles should be attached to the duct in such a fashion as to make it possible to remove them easily. They should definitely not be cemented or welded into place.

The large intake openings of the return ducts should be at least 7 ft above the floor and should be protected by a fine mesh screen to prevent the entering of papers, refuse, cigarettes, etc., into the ducts. Only too often do we find these large return openings in the bottom corner of a room where they are subject to blocking and used as a refuse can.

Fan Should Be Given Careful Attention

I finally want to touch on one of the most important items which, in many cases, does not receive the proper attention. The driving element of any air conditioning, ventilating, or exhaust system is the *fan.* It stands to reason, therefore, that the fan should receive just as much or even more attention as the rest of the system. Yet in five of 10 cases, it isn't even possible to find access to the fan proper inside of the fan housing. I am now speaking not only of the fan of an air conditioning system, but of every type of installation from a small kitchen exhaust system to an air conditioning system serving an entire building.

Our work brings us into contact with systems and fans of all sizes and I can truthfully say that more than half of the fan housings do not have access openings. This is particularly harmful in such cases as kitchen exhaust systems, where the fan exhausts the grease fumes from the kitchen ranges and invariably, after several years, the inside of the housing and the fan blades are so clogged up that the efficiency of the entire system is reduced to a minimum, to say nothing about the constant fire hazard. Aside from that there are, of necessity, considerable deposits of grease and oil inside the housing which become worse when the bearings begin to wear out and the lubricants are leaking onto the bottom and walls of the housing. This represents a definite fire hazard and it has been the sad experience of one of our customers, a war plant, to see a fire start in the fan housing due to the accumulations of grease and oils.

We have recently been called on to service the air conditioning and ventilating systems of one of the leading airplane manufacturers in the country and found thirteen 12 ft fans, 10 of which had no access doors whatsoever. Since the housings are of ¼ in. steel or sheet iron, it is a lengthy and difficult process to cut large doors into them. When we finally convinced the manager of the plant of the necessity of the expense, we found the bottom of almost every housing covered with a 2-3 in. layer of grease and lubricating oil which had come from the worn bearings. One spark could have set fire to the entire system and would, no doubt, have spread through the whole building, causing inestimable damage.

Fan Housing Should Have Access Door

There is no question in my mind that every fan housing, may it be 2 or 16 ft high, should have a proper opening with a door so that it can be kept clean—not only to remove the fire hazard but also to maintain the efficiency of the system. To cite a specific example, one of the leading New York restaurants was faced with a serious turnover of help in the kitchen due to excessive heat. The owner, in calling on us, explained that his kitchen used to be one of the coolest in the city but that during the past months the heat was getting worse and worse. After opening the fan housing by cutting an opening into the heavy steel, we found that the fan blades were covered completely with a thick layer of grease, thus reducing to a minimum their effectiveness in drawing the hot fumes from the space. After a thorough cleaning, the former pleasant conditions again prevailed.

In closing, I want to stress again the fact that entirely too little attention is being paid to the maintenance of all types of air conditioning and ventilating systems. They are considered as a one-time installation, but their lifetime could be lengthened two or threefold, if they received the right attention.

* * * * *

Comfort air conditioning is defined by the ASHVE Guide as the process by which simultaneously the temperature, moisture content, movement and quality of the air in enclosed spaces intended for human occupancy may be maintained within required limits.

Wartime Fuel Efficiency—A Review of Combustion Elements

By Kalman Steiner

THE USEFULNESS of a fuel lies in the heat that results from its burning. The process of burning a fuel is called combustion. Technical and scientific interest in combustion centers primarily in accomplishing the process at greatest efficiency—that is, in having fuels burn so that the greatest possible portion of the theoretically available heat is actually utilized. Combustion has been investigated, discussed, and described from the viewpoints of various sciences—chemistry, physics, thermodynamics, heat transfer, and so on. It will be the aim here to reduce the findings of these sciences to simple and practical terms that can be applied to the everyday purposes of burning fuel in boilers.

Technically, combustion may be defined as the process of union of substances with oxygen, accompanied in most cases with evolution of light and in all cases with evolution of heat. Although some fuels are still burned primarily for the generation of light, and are then designated as illuminants, we will not concern ourselves with that aspect of combustion. Usually, fuels are burned in order to release their heat energy. Chemists call combustion an oxidation, but many cases of oxidation occur outside the realm of combustion, such as the rusting of iron. It is perhaps worth noting that heat is released in such slow chemical reactions as the rusting of iron, but the rate of heat liberation is so slow that no perceptible temperature rise occurs. It will, therefore, be well to add to the definition that combustion proceeds at a rate sufficiently rapid so that the heat released causes a perceptible and significant temperature rise.

A great many substances enter into combustion, or in other words, a great variety of things will burn. It will not, at the outset of a discussion of combustion, tend to simplify the matter by considering the nature and diversity of combustible substances. Rather, a great simplification can be accomplished by investigating first the other substance that must always participate in the combustion reaction—oxygen. And since oxygen, with few exceptions, is furnished to the fire as air, this discussion will open by describing the nature of air and its function in the combustion process.

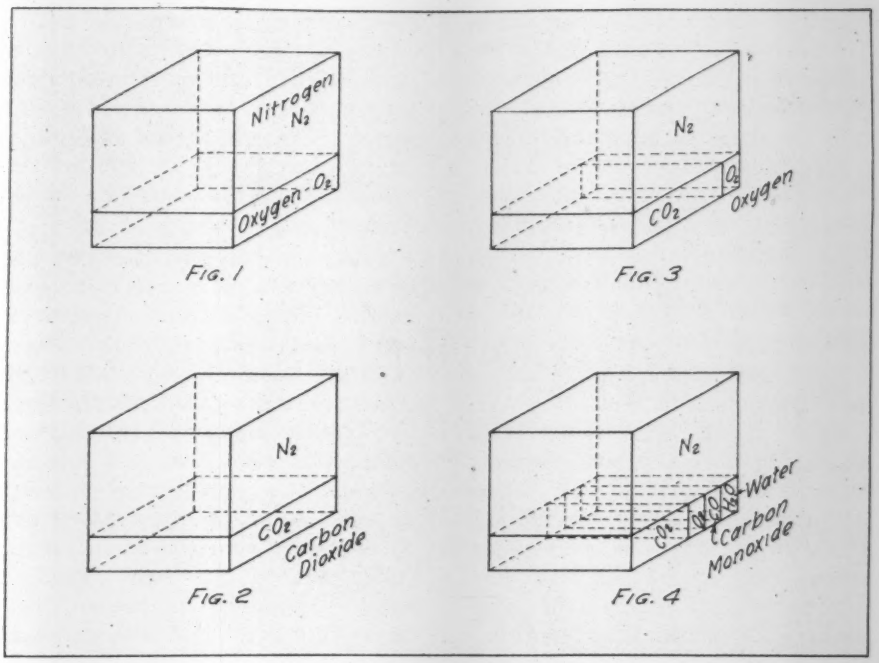


Fig. 1—Cube of air, represented with oxygen and nitrogen in separate layers. . . . Fig. 2—Cube of air after undergoing complete combustion with pure carbon, without excess air. . . . Fig. 3—Cube of air after undergoing complete combustion with pure carbon, excess oxygen remaining. . . . Fig. 4—Cube of air after undergoing incomplete combustion with carbon and hydrogen, excess air remaining, and some carbon monoxide formed

Maximum CO_2 Content of Flue Gases

The earth's atmosphere is a mixture of gases, of which the predominant constituents are nitrogen and oxygen. In addition, there are small percentages of certain rare gases, including argon, helium, and others. There is no need, however, to consider the rare gases in combustion. Air may be considered to consist of 79 per cent nitrogen and 21 per cent oxygen by volume. The oxygen alone participates in the combustion reaction; all other atmospheric gases are inert and are grouped as the nitrogen component.

Fig. 1 is an attempt to illustrate a cube of air by representing the oxygen and nitrogen in separate layers. As the cube of air passes into a firebox and comes in contact with the burning fuel, the only changes that affect the chemical composition of the air occur in the oxygen layer. Assuming that a particular fuel were pure carbon (which is hypothetical only, as no actual fuel is pure carbon), and that all the oxygen of this particular cube entered into combustion, and further that combustion proceeded to completion, then all the oxygen would have been completely changed to carbon dioxide. According to a well known principle of physics called Avogadro's Law, there will be no change in the number of gas molecules between the oxygen and the carbon dioxide which it forms, so that, were the gases cooled to the initial tempera-

ture, there would be no change in gas volume. In other words, regardless of expansion from temperature, the carbon dioxide composes a percentage of the original air cube identical to that of the oxygen from which it was formed. It follows, therefore, that when combustion is sustained by atmospheric air the theoretical maximum carbon dioxide content of the resultant flue gases is 21 per cent. Fig. 2 is a representation of the air cube after the oxygen has been quantitatively converted to carbon dioxide, the nitrogen remaining chemically unchanged. Actually, that theoretical maximum carbon dioxide content of 21 per cent is never attained in practice, for a variety of reasons.

The first of these reasons is that some unchanged oxygen always remains. Complete conversion of oxygen to carbon dioxide cannot be attained in combustion. There are a number of practical and scientific explanations why some oxygen passes through the firebox unchanged instead of combining with carbon. For one thing, oxygen can undergo transformation —that is, enter into chemical reaction—only upon coming directly into contact with the fuel. Practically, it is impossible to mix air and fuel so thoroughly and intimately that every molecule of oxygen comes into contact with a particle of unburned fuel. And even though physical contact between the oxygen molecule and the fuel particle occurs, there must exist an environment favorable to combination. The temperature must be sufficiently high and there must be an *excess* of oxygen to exert a mass effect upon the reaction. The important fact is that *in order to secure complete combustion of a fuel, it is necessary that there be present an excess of oxygen.* Fig. 3 represents the original air cube after undergoing combustion to the extent now indicated, i.e., complete combustion of the carbon fuel to carbon dioxide, with an excess of oxygen. The theoretical maximum carbon dioxide of 21 per cent is reduced by the amount of excess oxygen.

The second reason for not attaining theoretically perfect combustion is that all the carbon does not burn to carbon dioxide. There is an intermediate stage in carbon combustion, the gas carbon monoxide, which represents incomplete combustion of carbon. The formation of carbon monoxide is very undesirable, as it represents a serious loss of potential fuel energy. Only part of the fuel's heating value is utilized when carbon burns incompletely to carbon monoxide. It is the aim of combustion engineering to cause combustion to proceed as nearly as possible to completion, with unburned carbon monoxide at a minimum. But almost always there is at least a small percentage of it present in the flue gas. A molecule of atmospheric oxygen contains two atoms of oxygen, a fact expressed by the chemist's symbol for it, O_2; a molecule of carbon monoxide contains but one atom of oxygen as indicated by its chemical symbol, CO. Therefore, an increase of volume occurs in the formation of the monoxide, for each molecule of oxygen forms two molecules of carbon monoxide. Again by Avogadro's Law, the monoxide volume must be double that of the oxygen from which it was formed. Hence the proportion of carbon monoxide in the flue gases is reflected by twice as much reduction of carbon dioxide (CO_2) below the theoretical maximum.

Thus far it has been assumed that the fuel consists of pure carbon. All commercial fuels, however, contain some hydrogen. When hydrogen burns it forms water, H_2O, and thereby consumes a portion of the oxygen from the air. This further reduces the theoretical percentage of carbon dioxide in the flue gas. Fig. 4 shows the original cube of air as it would finally be represented in the flue gas, with carbon dioxide, carbon monoxide, oxygen, and water vapor present in addition to the original nitrogen. Since the water molecule contains but one atom of oxygen, it also causes an increase in gas volume in its formation, in a manner and amount analogous to carbon monoxide as already explained. Water vapor, however, condenses when its temperature falls below the dew point, so that conditions which have here been portrayed are true only so long as the water exists as vapor.

The most widely used index of the efficiency of combustion is the carbon dioxide content of the flue gases. The above discussion shows that as the percentage approaches 21 per cent, the more nearly perfect is the combustion, but that 21 per cent is theoretical only for pure carbon. The actual value of the theoretically perfect carbon dioxide percentage in the flue gas from various fuels depends upon the percentage of hydrogen present in the fuel.

Moisture Content of Fuel and Air Supply

The combustion system, from the entering fuel and air to the exit stack gases, receives moisture from two other sources than the combustion of hydrogen—namely, the moisture content of the air supply and the moisture content of the fuel as fired. The net effect of these two extraneous sources of moisture upon the gas analysis is almost nil, because all analyses of flue gas are made from or are based upon so-called dry gas, meaning gas cooled to room temperature and freed of all moisture except that which persists to saturate the remaining permanent gases. Of course, this does not imply that the presence of water in the air and fuel is not important. On the contrary, all water taken into the combustion system represents a fuel loss; water in fuel must be evaporated; water vapor from the fuel and from the air must then be

THEORY MUST be combined with practice if efficiency in the utilization of fuel—an important "military objective"—is to be attained. The process of combustion has been investigated, discussed, and described from the viewpoints of many sciences—chemistry, physics, thermodynamics, heat transfer, etc.—but the aim here is to reduce the findings of these sciences to simple and practical terms that can be applied to the everyday purposes of burning fuel in boilers. . . . Mr. Steiner is a member of HPAC's board of consulting and contributing editors

heated to the stack gas temperature.

The principal sensible heat loss of combustion is the heat required to raise the nitrogen and unconsumed oxygen from entering or room temperature to the final flue gas temperature, in addition to that carried in the products of combustion. It will be quite obvious that the lower the percentage of excess air, the less will be the waste of heat carried away by the hot gases. While all nitrogen is useless in combustion, it is inevitable that there be present the amount representing the residue from the air that furnished oxygen for combustion. Any excess air lowers the combustion efficiency, but it is recognized that some must be present as a practical measure. It is the aim of combustion engineering to consume fuel with minimum excess air.

Most fuels contain some sulfur. Sulfur burns to form an oxide, generally the dioxide, but sometimes there is formed a trioxide. In the analysis of flue gases by absorption, oxides of sulfur appear as CO_2; analyses made by conductivity methods would not detect them. In most cases the amount is so small that no appreciable error occurs in interpretation of the analysis without regard to sulfur oxides.

Calculating Fuel Loss from Flue Gas Analysis

The calculation of a fuel loss from the flue gas analysis involves evaluation of the quantity of gas resulting from the burning of a unit quantity of fuel under the conditions then prevailing. From knowledge of the gas quantity, gas temperature, and specific heat of the gas mixture, the sensible heat in the flue gas, above room temperature, is readily calculated. It is customary to express the sensible heat content of the flue gases as a percentage of the original heating value of the fuel.

The complete analysis of flue gas includes determination of carbon dioxide, oxygen, and carbon monoxide. The total of these three constituents subtracted from 100 per cent is taken to be nitrogen. It is not usual practice to analyze for unburned combustible other than carbon monoxide. Most permanent installations of flue gas analyzers and recorders show only the carbon dioxide content, however, along with the flue temperature. For rapid estimation of stack losses, charts are available showing heat loss for varying percentages of carbon dioxide at various flue gas temperatures.

It is important, however, to use a chart applicable to the fuel being burned. Obviously, since the theoretically maximum CO_2 depends upon the percentage of hydrogen in the fuel, there is a different fuel loss or excess air chart for every kind of fuel. Fortunately, the percentage of hydrogen is quite constant for each fuel type. It should be understood that the information given in a CO_2 chart is not the equivalent of an efficiency test. At best, the chart shows the percentage of available heat of the fuel lost in stack gases if all the assumptions upon which the chart is based are true. Often these assumptions do not hold, for usually there is some unburned combustible in the flue gas and usually the fuel itself contains some nitrogen.

Other losses in the average boiler plant include unburned combustible in the clinker from solid fuels, moisture in fuel and air supply, soot formation (smoke), radiation from the setting, and latent heat in the water of combustion.

It is possibly not logical that efficiency is charged with the loss of heat of condensation, because—strictly speaking—that heat is not available to the process. In the laboratory determination of fuel heating value, a fuel sample is burned in a calorimeter and the water formed by burning of hydrogen is condensed, adding its latent heat of condensation to the amount recorded. But in actual practice, the products of combustion are not cooled sufficiently within the boiler to permit such condensation. The custom, however, is to compute efficiency as the percentage of useful heat absorbed from the gross heating value of the fuel, rather than from the net.

Mention has already been made of the effect of mass action on the complete combustion of carbon to carbon dioxide. By mass action is meant the influence of concentration. Without going into the mathematics of chemical equilibria, it can be said that for every chemical reaction there is an equilibrium point at which the arithmetic product of the concentrations of the reacting substances (in this case carbon and oxygen) equals the product of the concentrations of the resulting substances (in this case carbon dioxide only). At the temperature of the flame, carbon dioxide tends to break up or dissociate into carbon and oxygen, or into carbon monoxide and oxygen. Therefore, in order to upset the equilibrium and force it to move in the direction of complete combustion or nonreversibility of the reaction, it is necessary to have present an excess of oxygen.

The passage of excess air through the firebox, it has been shown, lowers the efficiency by absorbing and carrying heat away in the stack gases. The engineer, then, is first presented with the problem of operating with minimum excess air, but is then confronted with the fact that as the air supply is restricted toward the theoretical, the law of mass action results in incomplete combustion. It then becomes necessary to determine the conditions that are most efficient for any given plant, or the amount of excess air that will yield the highest overall efficiency.

Factory Heating

HEATING THE factory uniformly and adequately is of prime importance in factory management. The problem is not so great in fully enclosed, brick buildings several stories high as it is in the one story, saw tooth, glass roof assembly plants of which so many have recently been built. In addition to roof radiation, large doors frequently are opened to permit the passage of trucks in and out with material or product. Worker's feet get cold, and when that happens, nothing but discomfort and dissatisfaction result. The engineer may have calculated correctly as to overall heat loss and supplied adequate radiation but totally overlooked the element of heat stratification—*from a letter on fuel utilization by Joseph Harrington, advisory engineer.*

HOW TO DESIGN AND INSTALL AN OIL BURNING SYSTEM

THE EDITOR—

In a single article, How to Design and Install an Oil Burning System, published in the December HPAC, Fred Meyer compressed a great deal of information and experience. It was a noteworthy piece of work. Of course, as can but be expected when a fairly broad subject is condensed considerably, a few points seem somewhat distorted or improperly presented. It appears to me the following portions of his article justify a bit of clarification or amplification.

Table 1 of his article contains useful information on furnace settings. Instead of or in addition to basing capacity on pounds of oil per hour, which basis does not have widespread usage among stationary engineers, I think it should contain at least corresponding gallons per hour, and perhaps also the most accurate basis of all, Mbh or heat release in thousands of Btu per hr. The same table gives a column of figures showing minimum clearance of burner centerline to furnace floor, and another showing minimum distance from burner centerline upward to boiler waterleg. It appears to me that these values, in the table cited, are established by the dimensions of the burner tile illustrated, rather than by actual flame requirements, and it might be mentioned that if conditions in some particular installation or with some other make of burner preclude the possibility of securing these minimum clearances, that by use of plastic refractory the cited minimums can be reduced.

Discussing a typical calculation of furnace length, Mr. Meyer shows that so far as heat release is concerned, the normal boiler furnace length of 77 in. is adequate, but that the table calls for a minimum length of 84 in., probably in consideration of flame characteristics. To secure the extra 7 in., Mr. Meyer would reduce his bridge wall thickness and sacrifice the insulation of the rear wall (where direct flame impingement results in highest refractory temperature), as well as constructing a false front ahead of the boiler front. I have seldom observed a flame so critical as to require these extreme precautions, involving the sacrifice of structural stability. I should think a slight change of burner air nozzle would sufficiently alter the flame size to prevent carbon formation on the back wall even with the lack of 7 in. of furnace length.

In his piping scheme Mr. Meyer illustrates a combustion control valve, obviously to regulate fire size in proportion to load demand, and he also indicates the burners to be full automatic, so that at maximum pressure one boiler might cut out, leaving others in operation. Unless this contingency is provided for in the piping scheme, I should think that under these conditions the burners remaining on the line would receive a greater flow of oil through the combustion control valves, for the reason that the total pump capacity is now delivered to fewer nozzles. In other words, I cannot see how the return circuit illustrated in the piping scheme would absorb the surplus oil resulting from shut down of one burner while other remained operating. It may be that the piping scheme incorporates some provision for viscosity compensation, but if so, neither the text nor the diagram mention it.—KALMAN STEINER, member of HPAC's board of consulting and contributing editors.

When engineers gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." Some of the audience may offer comment amplifying the speaker's remarks, others will disagree with points the speaker may have made, and some will want to ask questions for the speaker to answer . . . We follow this custom in these columns, which provide an opportunity for readers to comment and discuss articles published in HPAC and other topics of interest to heating, piping, and air conditioning engineers and contractors.

HEATING, VENTILATING, AND AIR CONDITIONING HOSPITALS

THE EDITOR—

Referring to comments of E. W. Jones on page 676 of the December HPAC on my article in the November issue, double glazing in some form or effect is definitely necessary in hospital operating rooms and similar locations of high relative humidity conditions. The suggestion of glass block has been used in numerous instances, but provision for access to exterior surfaces for frequent washing must be provided. With double wall construction of rooms, a double glazing effect is secured by sash in the inner as well as the outer wall providing air space between. This arrangement also provides normal access for cleaning.

Mr. Jones' reference to overheating of hospitals emphasizes the need of temperature control, which is so frequently lacking. Inasmuch as radiation must be installed to offset heat loss at the lowest outside temperature, it naturally follows that the building will be overheated if the same amount of radiation is used at a higher outside temperature, unless the temperature of the heating medium supplied is regulated accordingly. Wind and sun effects, as well as outdoor temperature, can be compensated for by a simple zone control system, effecting a saving in fuel and providing more uniform and comfortable heating.

Air conditioning for a wing or floor of special hospital rooms is commendable if funds are available. If not, a number of portable self-contained units can be used, with the air intakes and exhausts connected to window openings. These units are usually provided with filters, which would be of benefit to allergy patients, or the cooling units could be used in conjunction with separate filtering and supply units.—J. G. MENCH.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Looking Ahead in 1945

As THE fiftieth year of our activity as an engineering society draws near its close, we find vastly changed and still changing world. Important political and economic events are still in the making. Optimists have been wrong about the duration of the war and we hope the pessimists are equally wrong, but whatever the duration may be, it is plain that the technical fields are affected greatly.

The transfer of technical leadership from the old to the new world, which has been occurring for some years, has received a great impetus from the war and the engineering societies are in a position to make important forward strides in the near future.

The pressure of events, the change and relocation of personnel, and the increased interest in the activities of the American Society of Heating and Ventilating Engineers have brought about not only a large increase in membership and in the number of active chapters, but also a reorganizing process looking to the greater responsibilities and potentialities in our field. More members, both individually and through the chapters, are interested in what is being done and what is planned, thus showing the necessary, healthy condition of a sound and growing society.

Our Research Committee, with the enthusiastic support of the Council, has laid out a sound and detailed program as given in the booklet recently published which cannot fail to convince the reader of the sincerity of purpose and ability to meet the challenge of our time. A concomitant condition essential to the success of the program is that all industries involved should recognize the importance of the program to the general welfare and that the necessary financial support should be forthcoming. These efforts will contribute in large measure to easing the burden of conversion to peacetime pursuits.

We have taken the initiative by inviting a number of technical societies and organizations to appoint representatives to an International Joint Committee on Psychrometric Data and have received immediate, complimentary support by the prompt acceptances. The first meeting on this matter will be held at the 51st Annual Meeting in Boston.

An additional Joint Committee on the subject of Industrial Ventilation and Air Conditioning is in the making, which will get under way later in the year.

Membership in the Society continues to increase at a healthy rate; charters were presented to the Chapter at Salt Lake City in December and one is ready for the Central New York Chapter at Syracuse in January.

A great variety of subjective and geographical interests are welded together in the cooperative efforts of our Society and concrete evidence of the results will be forthcoming at the annual meeting in Boston beginning January 22.

S H Downs

December 26, 1944. *President.*

Studies of the Mechanism of Solution of CO_2 in Condensates Formed in Steam Heating Systems of Buildings†

By Leo F. Collins,* Detroit, Mich.

SUMMARY—These studies have shown that Henry's and Dalton's laws accurately describe the conditions controlling the CO_2 contents of condensates formed in steam heating systems using CO_2-bearing steams. The anomalies, noted in the past, have resulted from an imperfect application of these laws. The most important error has been the postulate that, in the vapor space of condensers, steam and CO_2 form a homogeneous mixture containing CO_2 concentrations of the same order of magnitude as in the incoming steam. Rather, it has been shown, these two gases form a gradient mixture much richer in CO_2 than is the incoming steam. The highest CO_2 concentration persists at the end of the steam path. The latter, because of the conventionalities of design, is usually at the condensate level. In other than one-pipe systems these factors conspire to bring about solution of CO_2 in the condensate in the condenser of about 25 per cent of the CO_2 entering the unit. The undissolved gas escapes through the thermostatic trap into the return line. In the latter, there is a progressive pick-up of CO_2 by the condensate, except in high vacuum lines where little or no change occurs.

In one-pipe systems that operate for long periods of time the CO_2 in the condensate as it emerges from the condenser is likely to be several times that in the incoming steam; as the condensate travels down stream the CO_2 content of the condensate eventually assumes a value equal to that in the incoming steam. However, gas-binding of the condenser seems unlikely unless non-condensable gases other than CO_2 are entrained with the steam.

WHILE CORROSION is always the resultant of simple chemical reactions, most of the industrial problems so created are complicated, because they embody the simultaneous operation of a number of elementary processes. To understand what takes place, one must be able to accurately appraise not only the chemical and physical factors involved but also their relative bearing upon one another as conditions change with different operating procedures. At times, all of these stipulations cannot be met, but there exists, nevertheless, the necessity for *explaining* corrosion phenomena. Under such circumstances, postulates must be used.

In the field of steam heating system corrosion, the mechanism of the solution of carbon dioxide has been postulated for the most part. The assumptions that necessarily had to be made dealt with the physico-chemical factors presumed to control the CO_2 content of condensates. It was noted frequently, however, that the CO_2 contents of condensates, drained from operating systems, were far greater than theory predicted, and it was suspected that some of the basic postulates must be in error. For these general reasons, the studies reported herein were begun. It was hoped thereby to obtain a picture of the mechanism by which CO_2, entering condensers with steam, becomes dissolved in the condensate.

General Findings

The general findings are that theory (Henry's and Dalton's Laws) accurately define the factors controlling the CO_2 content of condensates; that the apparent anomalies between theory and field findings have resulted from an imperfect application of the laws. It is shown that the mechanics of condensation, as employed in common types of heating equipment, favor the production of condensates containing a high percentage of the CO_2 entrained with the steam; and that there is a progressive pick-up of CO_2 as the condensate moves down the return system.

The Corrosivity of CO_2-Bearing Condensates

In an experimental set-up the potential corrosivity of CO_2-bearing condensates, at about 200 F, has been shown[1] to subscribe to the equation:

$$P = 0.46W^{0.82}$$

where P = corrosion rate as average penetration in inches per year x 1000. (Values of 20 or more are believed to indicate serious corrosion).

W = pounds of dissolved CO_2 contacting the metal surface in one hour x 100,000. (Equals CO_2 content of condensate in ppm x pounds of condensate flowing per hour x 0.1).

If this, or a comparable relationship, holds in actual practice, then it is clear that even low concentrations of dissolved CO_2 are capable of causing corrosion troubles. Thus a complete knowledge of the mechanism which controls the solution of CO_2 by condensate should be helpful in designing corrosion control expedients.

†Results of research studies in The Detroit Edison Co.,

*Consulting Engineer, member of ASHVE.

For presentation at the 51st Annual Meeting of the American Society of Heating and Ventilating Engineers, Boston, Mass., January 1945.

[1] *Power Plant Engineering* (L. F. Collins), January 1944.

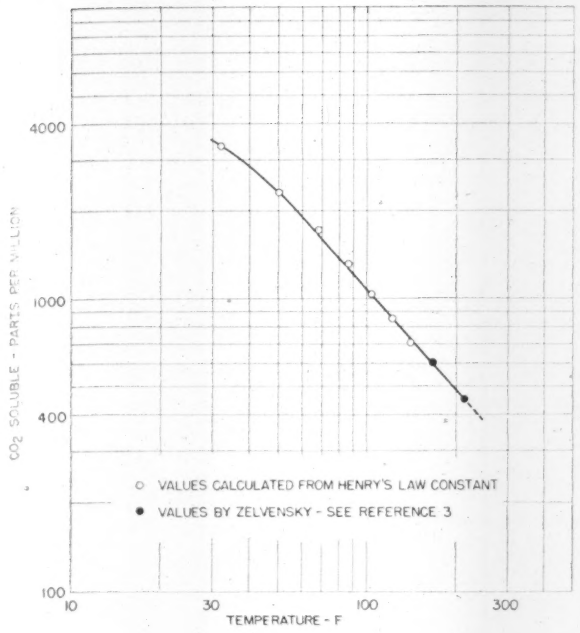


Fig. 1—Specific solubility of carbon dioxide in otherwise pure water at a partial pressure of 14.696 psi absolute

Factors Determining the CO_2 Content of Condensates as Predicted by Theory

Theory holds that for any gas which does not react with water, the amount absorbed by a unit quantity of water, under conditions of equilibrium, decreases with increased temperature and is directly proportional to the pressure exerted by the gas upon the exposed surface of the solution.

A corollary states that when a mixture of gases is in contact with water at a given temperature, there will be dissolved an amount of each gas corresponding to that part of the total gas pressure each exerts upon the water.

The rate of hydration of carbon dioxide to form carbonic acid has been measured, most recently, by Mills and Urey[2] who also summarize the work of early investigators. These studies show that the rate of hydration is immeasurably fast, especially at the boiling point of water, but that less than one per cent of the total CO_2 present is combined with water as carbonic acid.

The specific solubility of CO_2 in water has been studied by a large number of investigators, most recently by Zelvensky[3], who critically reviews most of the published data. He shows that, for low CO_2 concentrations, calculations based upon Henry's Law are valid. The curve in Fig. 1 shows the results of such calculation when the pressure of CO_2 in the vapor phase is one atmosphere. The values from 32 to 140 F are based upon a plot of Henry's Law constant[4] and those from 140 to 212 F upon the data of Zelvensky[5], Bohr and Bock[6]. The extrapolation, shown by the broken line portion of the curve, has been made to cover the higher temperatures commonly found in steam heating equipment.

All of these data indicate that the amount of CO_2 in solution in the condensate flowing from any heating equipment will be governed principally by the CO_2 concentration of the steam in the vapor space of the equipment.

The CO_2 content of steams, used for heating purposes, usually is below 50 ppm, although occasionally values of the order of 100 ppm are encountered. If the mechanics of condensation were such as to cause CO_2 values of this order (up to 100 ppm) to persist in the vapor space of steam condensing apparatus, calculations based upon Henry's Law show that immeasurably small amounts[7] of CO_2 will be dissolved in the condensate. Nevertheless, it has been shown[8,9] that readily measurable amounts are often found. The first aim of these studies was to resolve these apparent contradictions.

Test Technique

Two water-cooled condensers, arranged as shown in Fig. 2, were used as experimental units. A *sep-*

[2] *Journal American Chemical Society* (G. A. Mills and H. C. Urey), Vol. 62, 1940, p. 1019.

[3] *Journal Chemical Industry* (USSR—Y. D. Zelvensky), Vol. 1, 1937, p. 1250.

[4] International Critical Tables, Vol. 3, p. 260 (McGraw-Hill Book Co., Inc.)

[5] Loc. Cit. Note 3.

[6] Physico-Chemical Tables (Bohr & Bock), Vol. 2, 996, Lippincott, 1911.

[7] Dissolved CO_2 concentrations of less than one part per million cannot be accurately determined with the methods commonly used.

[8] Some Fundamental Considerations of Corrosion in Steam and Condensate Lines, by R. E. Hall and A. R. Mumford. (ASHVE Transactions, Vol. 38, 1932, p. 121.)

[9] Corrosion in Steam Heating Systems, by L. F. Collins with E. L. Henderson. (Heating, Piping and Air Conditioning, September 1939-May 1940, inclusive.)

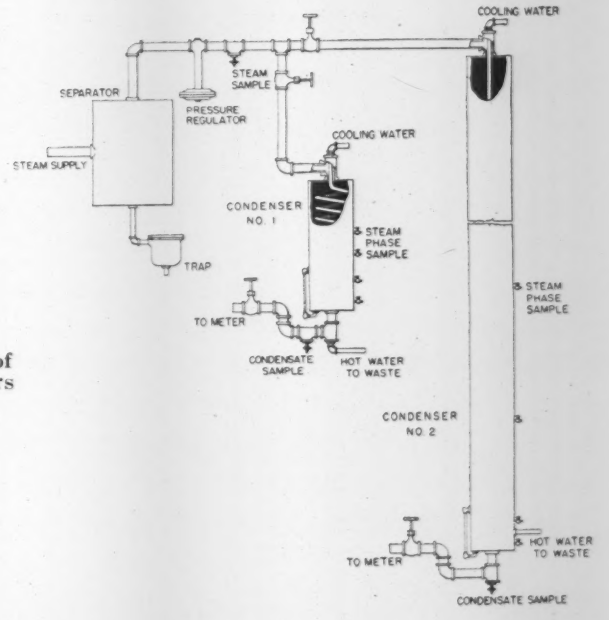


Fig. 2 — Arrangement of experimental condensers

arator was provided to prevent entrainment of boiler water salines, some of which interfere with the measurement of CO_2. The cooling water was made to run parallel with the flow of steam to prevent *under-cooling* of the condensate. The rate of condensation was controlled by regulating the flow of cooling water. Steam pressure was automatically maintained at 5 psi gage by means of a reducing valve. Provisions were made for sampling the incoming steam, the vapor at various elevations in the steam space of the condenser, and of the condensate leaving the units. Escape of undissolved gas, along with the condensate, was prevented by throttling the discharge line so as to keep condensate always visible in the gage glass.

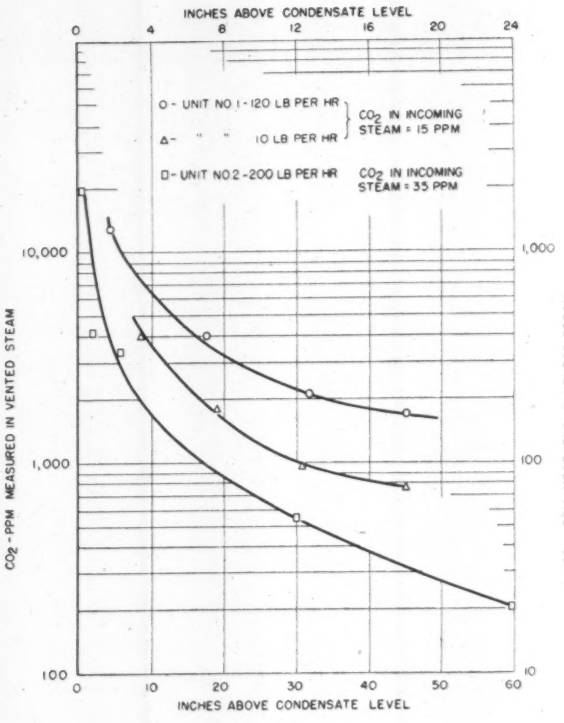

INCHES ABOVE CONDENSATE LEVEL
0 4 8 12 16 20 24
O - UNIT NO 1 - 120 LB PER HR
Δ - " " 10 LB PER HR
CO2 IN INCOMING STEAM = 15 PPM
□ - UNIT NO 2 - 200 LB PER HR
CO2 IN INCOMING STEAM = 35 PPM
CO2 - PPM MEASURED IN VENTED STEAM
10,000
1,000
100
1,000
100
10
0 10 20 30 40 50 60
INCHES ABOVE CONDENSATE LEVEL

Fig. 4—CO_2 content of vapor phase at different heights above condensate level

Time-Rate of Solution of CO_2

When these units were operated at different condensating rates, and with different amounts of CO_2 present in the incoming steam, it was found that, in a comparatively short period of time, the condensate contained an amount of CO_2 equal to that in the incoming steam. The progressive increase in the CO_2 content of the condensates with time is plotted in Fig. 3.[10] In view of the theory described previously, it was reasoned that for complete solution to occur the CO_2 content of the steam in the vapor space of the condensers must be much higher than in the incoming steam. This led to a study of the vapor phase at various levels.

CO_2 Content of the Vapor Phase at Different Levels

Repeated analyses of samples drawn from the vapor phase at different levels gave results typified by the curves in Fig. 4. These data are believed to provide a satisfactory explanation to the apparent contradiction between pure theory and actual operating conditions. They show clearly that in the vapor space steam and CO_2 do not form a homogeneous mixture of the same composition as in the incoming steam, as has been postulated,[11] but rather a gradient mixture several times richer in CO_2 than the incoming steam with the highest CO_2 concentration persisting at the *end of the steam path.*

In the test units, as in most designs of heating equipment, the end of the steam path was at the bottom. The curves in Fig. 4 indicate that at the condensate-gas interface the CO_2 concentration of the steam was several thousand parts per million. Curves A and B of Fig. 5, calculated upon the basis of Henry's Law, encompass the pressure range common to steam heating equipment. They show that CO_2 concentrations of the order indicated by Fig. 4 had to persist to bring about solution of CO_2 in amounts shown by the curves in Fig. 3. It should be noted, too, that lower CO_2 values in the steam phase are required when *undercooling* of the condensate occurs, as in certain types of water heaters.

Experimental difficulties precluded examination of the vapor

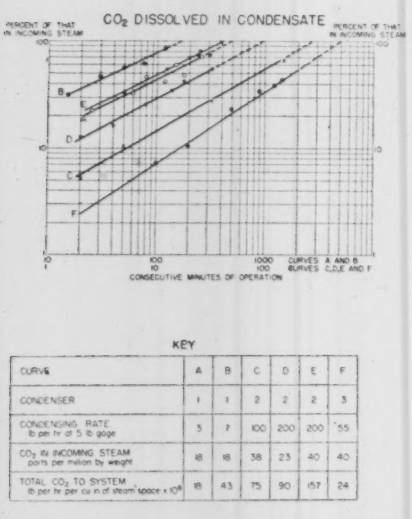

CO2 DISSOLVED IN CONDENSATE
PERCENT OF THAT IN INCOMING STEAM
CONSECUTIVE MINUTES OF OPERATION
CURVES A AND B
CURVES C,D,E AND F
KEY
CURVE A B C D E F
CONDENSER 1 1 2 2 2 3
CONDENSING RATE lb per hr at 5 lb gage 5 7 100 200 200 55
CO2 IN INCOMING STEAM parts per million by weight 18 18 38 23 40 40
TOTAL CO2 TO SYSTEM lb per hr per cu in of steam space x 10^6 18 43 75 90 157 24

Fig. 3—Progressive increase with time of CO_2 content of condensates

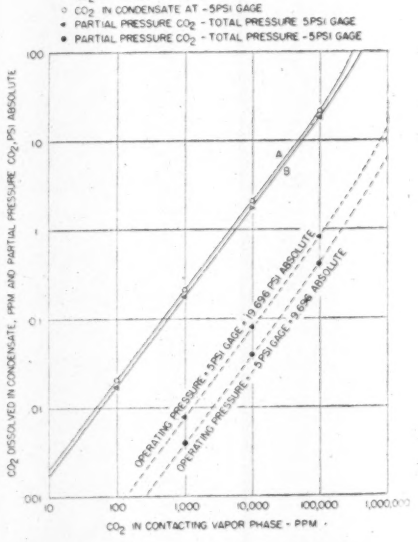

CO2 IN CONDENSATE AT 5PSI GAGE
CO2 IN CONDENSATE AT -5PSI GAGE
PARTIAL PRESSURE CO2 - TOTAL PRESSURE 5PSI GAGE
PARTIAL PRESSURE CO2 - TOTAL PRESSURE -5PSI GAGE
CO2 DISSOLVED IN CONDENSATE, PPM AND PARTIAL PRESSURE CO2, PSI ABSOLUTE
OPERATING PRESSURE - 5PSI GAGE = 19.696 PSI ABSOLUTE
OPERATING PRESSURE - 5PSI GAGE = 9.696 ABSOLUTE
CO2 IN CONTACTING VAPOR PHASE - PPM

Fig. 5—Relation of CO_2 dissolved in condensate and partial pressure of CO_2 in contacting vapor phase

[10]Curve F was obtained from a very large cast-iron radiator used for other studies hereinafter reported.

[11]Loc. Cit. Note [9].

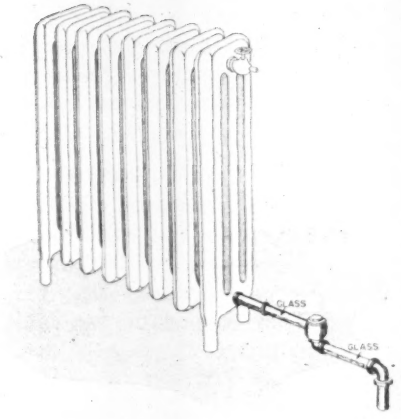


Fig. 6—Arrangement of radiator for thermostatic trap vent studies

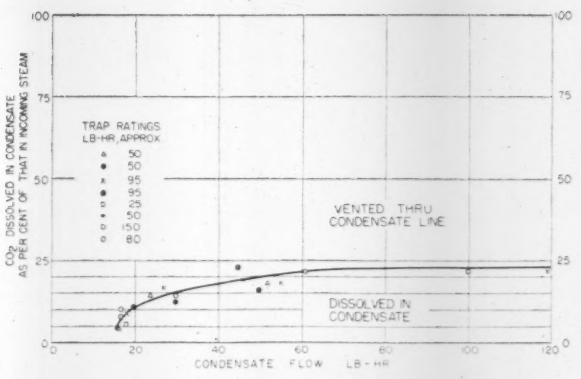


Fig. 7—Relation of CO_2 vented into condensate line and dissolved in condensate to quantity of condensation flowing through traps

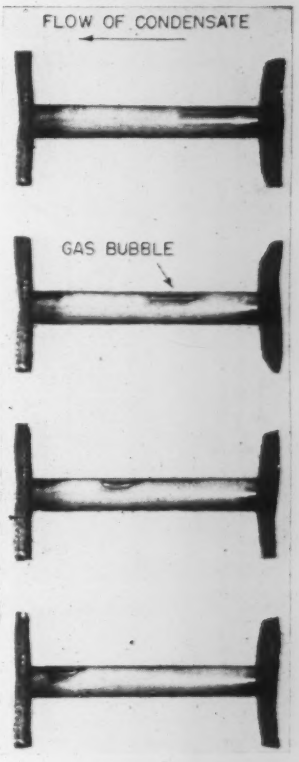


Fig. 8—Photographic evidence of occlusion of undissolved gas in condensate passing through thermostatic trap

layer closer to the condensate than the value shown in Fig. 4, *i.e.*, about two inches. When attempts to do so were made, condensate was entrained with the vented steam.

In view of the fact that CO_2 concentrates at the end of the steam path, two questions present themselves:

1. Why not vent off the gas to the atmosphere thus reducing proportionately the amount dissolved in the condensate?

2. Why is it that since conventional designs of equipment are seldom, if ever, provided with a venting device for removal of CO_2 and while measurable amounts of CO_2 are commonly found in solution in the condensate leaving such equipment very seldom is it equal to that in the incoming steam?

Detailed studies covering the first question have been made and the results reported elsewhere.[12] Satisfactory answer to the second question, it is believed, has been obtained during the present studies.

Accidental Venting and Solution in Return Lines

If a condensing unit, using CO_2 bearing steam, operates continuously, and the CO_2 dissolved in the outgoing condensate remains consistently less than in the incoming steam, and if the general principles previously established herein are valid, then it follows that *accidental* venting must take place. If this occurs through the trap into the return line, two interesting questions are posed:

1. Do conventional types of thermostatic traps permit the escape of undissolved non-condensable gases?

2. What becomes of the undissolved CO_2 as it moves down the return line?

Venting Through Thermostatic Traps

To study the escape of undissolved gas through different makes of thermostatic traps, a cast-iron radiator with a rated capacity of slightly more than 200 sq ft was equipped as shown in Fig. 6. Condensing rates were varied by blanketing the radiator with a tarpaulin and by exposing it to cold air admitted through a window.

It was found that when the amount of condensate flowing was not in excess of the rated capacity of the traps, the amount of gas vented into the return line and that dissolved in the condensate was as shown by the plot in Fig. 7.

The movement of non-condensable gas, occluded as bubbles, through the glass return line preceding the thermostatic trap was recorded, and a few of the pictures attesting this fact are shown in Fig. 8. That the bubbles were gas and not steam is attested by the facts (1) that their impingement upon the bellows caused no reaction, and (2) the condensate in the return line surged violently when steam bubbles were present.

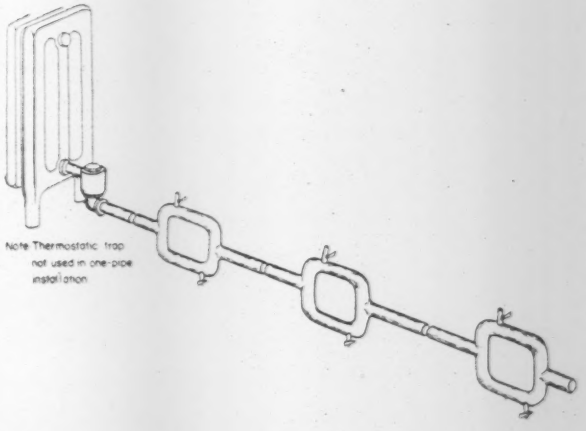


Fig. 9 — Arrangement of return line in resolution studies

[12]Preventing the Solution of CO_2 in Condensates by Venting of the Vapor Space of Steam Heating Equipment, by D. S. McKinney, J. J. McGovern, C. W. Young, and L. F. Collins (to be presented at the 51st Annual Meeting of the American Society of Heating and Ventilating Engineers, Boston, Mass., January 1945).

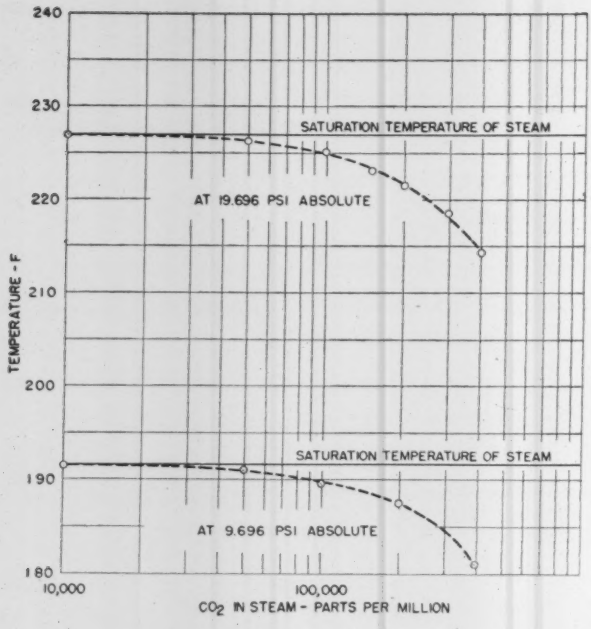


Fig. 10—Temperature pressure relationship for CO_2-steam mixture

Solution of CO_2 in Return Lines

For these studies, the specially designed return line, shown in Fig. 9, was used. The *loops* served as wells from which samples of condensate could be withdrawn without entraining undissolved gas, and the upper half of the loops provided a path for movement of undissolved gases—and for steam when the set-up was operated as a one-pipe system.

One-Pipe System: Such systems usually operate within a pressure range of from slightly above atmospheric to five psi gage. The accumulations of CO_2 in the vapor space necessary to cause complete solution of CO_2, in amounts equal to that in the incoming steam, (*i.e.*, up to 50 ppm), depress the temperature of the resulting steam-CO_2 mixture a negligible amount as compared to pure saturated steam at the same total pressure. This is attested by the curves in Fig. 10. Thus, despite the fact that condensers on one-pipe systems are always provided with a thermostatically operated air-vent valve, they are in reality unvented insofar as CO_2 is concerned.[13]

Because of these facts, the radiator in these tests was not provided with a vent. The data in Table 1 show the gradual increase in dissolved CO_2 measured at key points over an operating period of 72 consecutive hours. The test was discontinued at the end of 72 hours because the radiator became partly *gas bound.* That the gas binding was due to air, not CO_2, is attested by an analysis of the accumulated non-condensable gas which gave the following results:

	Per Cent
Carbon dioxide	6.8
Oxygen	9.7
Hydrogen	4.3
Carbon monoxide	0.2
Nitrogen	79.0

The presence of oxygen and nitrogen is explained by the fact that the boiler feedwater, from which the steam was derived, was not completely deaerated.

Vacuum Return System: When operated as a vacuum return system—*i.e.*, with the radiator at a *positive* pressure and the return line under *vacuum*—the results typified by the data in Table 2 were obtained.

Each of the values shown in Table 2 is an average of conditions which persisted for periods of from five to ten consecutive days.

From these data it is clear that in vacuum return lines the condensate progressively dissolves CO_2 as it flows along, due apparently to decreasing condensate temperatures; but that the percentage increase is less as the vacuum on the lines reaches the higher values. It is equally clear that even a high vacuum does not guarantee a CO_2-free condensate where a CO_2-bearing steam is used.

A reason for the decrease in the CO_2 resulting from the passage of condensate through the vacuum pump and meter, where it comes into contact with the atmosphere, is postulated in the Appendix.

Vacuum System: When operating with both the radiator and return line at negative pressures, results

Table 1—CO_2 solubility data—one-pipe system

Consecutive Hours of Operation	Condensing Rate Lb per Hr	Per Cent of Incoming CO_2[a] Dissolved in Condensate			
		Leaving Radiator	After Traversing Supply Line for 5 Ft	10 Ft	15 Ft
0.5	50	8	[b]	[b]	[b]
16	50	47	14	13	10
25	48	88	32	24	20
72	42	220	120	93	53

[a] CO_2 in Incoming Steam = 29 ppm.
[b] Unable to Obtain Satisfactory Sample.

Table 2—CO_2 solubility data—vacuum return system

Condensing Rate Lb-Hr	CO_2 in Steam ppm	Per Cent of Incoming CO_2 Dissolved in Condensate					Vacuum on Return Line[c]
		Leaving Radiator[a]	After Traversing Return Line for 5 Ft	10 Ft	15 Ft	Leaving Meter[b]	
55	34	6	9	23	52	21	4 to 8
88	32	11	12	26	37	13	8 to 12
110	38	84	20	28	29	9	12 to 20

[a] Radiator Operating Pressure: 5 psi gage.
[b] Atmospheric Pressure.
[c] In. Hg.

Table 3—CO_2 solubility data—vacuum system

Condensing Rate Lb-Hr	CO_2 in Steam ppm	Per Cent of Incoming CO_2 Dissolved in Condensate					Vacuum In. Hg on Radiator	Return Line
		Leaving Radiator	After Traversing Return Line for 5 Ft	10 Ft	15 Ft	Leaving Meter[a]		
42	27	70	70	68	67	11	2 to 4	12 to 20
72	35	77	77	75	71	17	2 to 4	4 to 8

[a] Atmospheric Pressure.

[13] Thermostatic air vent valves open at temperatures about 30 F below the temperature of saturated steam and close at temperatures about 20 F below that of saturated steam. (Private communication from a manufacturer.)

Table 4—CO_2 solubility data—gravity return system

Condensing Rate Lb-Hr	CO_2 in Steam PPM	Per Cent of Incoming CO_2 Dissolved in Condensate: Leaving Radiator	After Traversing Return Line for 5 Ft	10 Ft	15 Ft	Leaving Meter	Operating Pressure PSI-Gage: Radiator	Return Line
55	34	6	29	65	100	..	4	0
90	35	80	74	80	83	45	4	0

typified by the data in Table 3 were obtained.

The data in Table 3 are the average of conditions persisting for periods of from five to ten days.

A comparison of the data of Tables 2 and 3 show that with the experimental condensers operating under a slight vacuum more CO_2 is dissolved than under a positive pressure, all other conditions being equal. This, it is believed, results from the lower condensate temperatures under vacuum conditions. It is also worth noting that, when large amounts of CO_2 are dissolved (note the condensation rate of 110 lb/hr—Table 2), flashing of the condensate into a vacuum return causes a considerable increase in the dissolved CO_2 content, whereas (Table 3) when little or no flashing occurs through the thermostatic trap, there is no release of CO_2.

Gravity Return System: When the radiator was operated at a positive pressure and the return line at atmospheric pressure, results typified by the data in Table 4 were obtained.

The data in Table 4 show that as the condensate moved down the return line there was a progressive pick-up of CO_2 until the condensate contains an amount equal to that in the incoming steam. Whether this resulted from decreasing condensate temperature or the accumulation of CO_2 in the vapor space of the return line (in the manner previously described for condensing apparatus) or for some other reason is not clear at this time. An interesting observation is the decrease in CO_2, at the higher condensing rate, produced by the condensate flashing as it passed the thermostatic trap. The same thing is shown, for the highest condensation rate, in Table 2.

APPENDIX

Concerning Influence of Iron Reaction Products

Plugging of the return line immediately following thermostatic traps frequently is one of the chief causes of corrosion troubles. Analyses of a large number of such deposits have shown them to consist of iron reaction products. Invariably, the outer crust is of ferric iron, the layer adjacent to the metal is of ferrous iron, and the intermediate strata is of magnetic oxide. The author has postulated, on occasions, that these deposits result from (1) the solution of iron in the condensate in the condenser which (2) quickly oxidize after entering the return line where, invariably, air is present. In the present studies, an opportunity was afforded to obtain proof of these reactions.

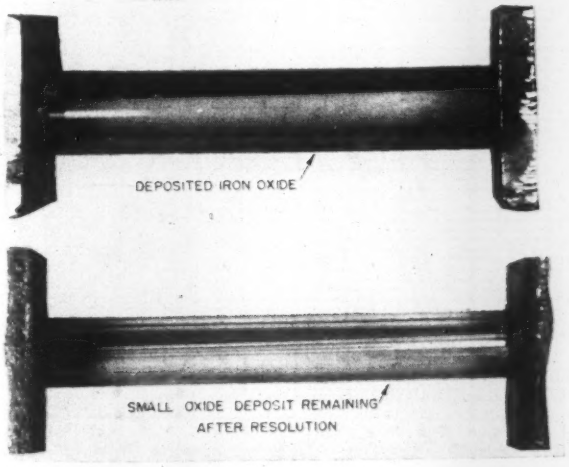


Fig. 11—Photographic evidence of formation and resolution of ferric iron in a return line

Precipitation and Resolution of Iron Reaction Products

In the thermostatic trap vent studies, wherein the glass return lines were available, no rust deposits were ever found preceding the trap. However, when the system was operated so that the line following the trap was about half full of condensate, and air could, therefore, seep back to the trap, a generous layer of red oxide would be formed in two or three days. If, subsequently, the condensation rate was raised so as to cause the return line to stay full of condensate, no deposit formed and that already deposited would redissolve. The pictures in Fig. 11 show the return line after the deposit had formed and the same line after resolution of most of the deposit.

Indices of the Influence of Ferrous Iron On the Solubility of CO_2

In Tables 2, 3, and 4 of the main text, it is seen that in every instance there was a decided decrease in the CO_2 content of the condensate after it had passed through the condensation meter. Upon passing the latter, it came into contact with the atmosphere.

Samples drawn preceding the meter were always water-white, while those after the meter always contained precipitated ferric iron. It is felt that the presence of ferrous iron materially influences the solubility of CO_2 in such solutions. This would explain the sudden loss of CO_2 by the condensate upon passing through the condensate meter, where the ferrous iron was quickly oxidized to the ferric state.

Check analysis of iron-ladened condensate samples by the evolution method as against direct titration with standard sodium bicarbonate, using phenolphthalein, failed to show that the iron reaction products fouled the direct titration method.

A few analysis of iron-ladened condensate gave the results shown below:

pH Value[a]	CO_2 PPM[b]	Total Iron as PPM Fe_2O_3[c]
5.5	2	0.8
5.5	8	1.3
5.7	2	0.8
5.7	27	4.6
5.9	11	5.5
5.9	36	24.5
6.2	27	17.0
6.2	16	36.8
4.8	135	36.1

[a]Determined electrometrically using glass electrode.
[b]By direct titration with Na_2CO_3 using phenolphthalein.
[c]Determined gravimetrically.

Whether these data have significance is not known. It is interesting to speculate, nevertheless, on the possibility of reducing CO_2 attack by oxygenation of the condensate.

Summer Weather Data and Sol-Air Temperature—Study of Data for Lincoln, Nebraska

By C. O. Mackey*, Ithaca, New York

This paper is the result of research sponsored by the American Society of Heating and Ventilating Engineers in cooperation with Cornell University

SUMMARY—A study of summer weather data at Lincoln, Neb., during a ten-year period from 1932 through 1941 is used for determining the design sol-air temperatures

SUMMER WEATHER data taken by the United States Weather Bureau at its station in Lincoln, Neb., during a ten-year period from 1932 through 1941 are used in this paper to determine design sol-air[1] temperatures for that city. This study was made at the suggestion of the ASHVE Research Technical Advisory Committee on Cooling Load in Summer Air Conditioning.

The station at Lincoln is located at a north latitude of 40°50′, a west longitude of 96°45′, and an altitude of 1225 ft. It is believed that the solar radiation results obtained at this station are very representative of the Great Plains area. Observed data were (1) hourly readings of the dry-bulb temperature of the outdoor air in the shade, (2) hourly readings of the total solar and sky radiation incident upon a horizontal surface, and (3) hourly wind movement. These data were obtained for each hour of the day during each day of the four months of June, July, August, and September for the ten-year period from 1932 through 1941. For example, for the hour ending at 9 a. m. in the month of July, there were 310 readings of each of the three variables—air temperature, total solar and sky radiation, and hourly wind movement.

The method of analysis of the data was the same as that followed in the earlier paper.[2] The sol-air temperature at each hour, for materials which do not directly transmit solar radiation, may be found from the equation:

$$t_e = t_a + \frac{bI}{4} \quad \text{.....(1)}$$

where

t_e = sol-air temperature, Fahrenheit;
t_a = temperature of the outdoor air in the shade, Fahrenheit;
b = absorptivity of the surface for solar radiation;
I = intensity of total solar and sky radiation incident upon the surface, Btu/hr ft².

Strictly, a value of the outdoor air film coefficient that varied with wind velocity should be used in Equation 1, but, for simplicity, a constant value of 4 Btu/hr ft²F was used. This question is discussed in Appendix A.

Temperatures of the outdoor air in the shade, and sol-air temperatures for the horizontal surface are precise, since they depend upon observed data only. As explained in the earlier paper,[3] the calculation of sol-air temperatures for vertical surfaces of various orientations involves certain arbitrary assumptions, because the total solar and sky radiation incident upon these surfaces is not actually measured at the stations of the Weather Bureau. One assumption involves the ratio of direct to diffuse radiation received upon the horizontal surface as a function of solar altitude. The same graph of this function was used in this paper as in analyzing the New York data. Another assumption concerns the diffuse sky radiation incident upon vertical surfaces of different orientations at different times of the day; as in the earlier paper, it was assumed that the diffuse sky radiation incident on a vertical surface

[3]Loc. Cit. Note 1.

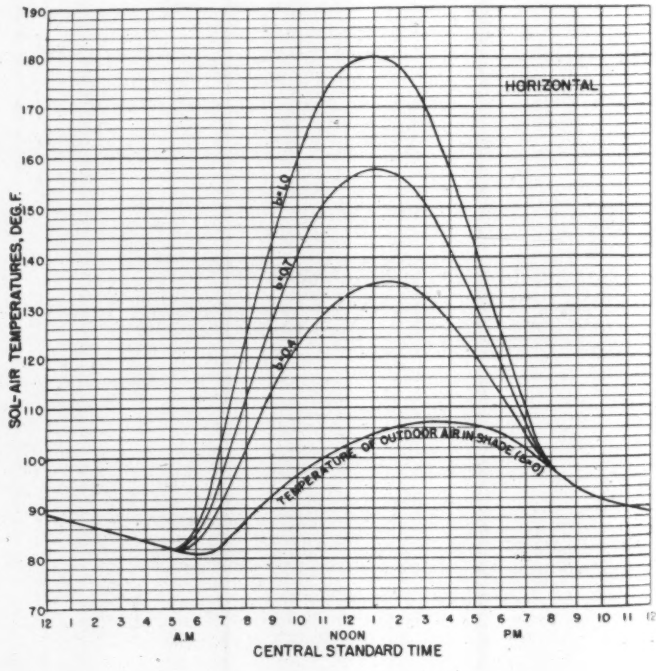


Fig. 1—Design sol-air temperatures for horizontal surfaces in Lincoln, Nebraska.

*Professor of Heat-Power Engineering, Cornell University. Member of ASHVE.

[1]Summer Weather Data and Sol-Air Temperature—Study of Data for New York City, by C. O. Mackey and E. B. Watson. (Journal Section, Heating, Piping and Air Conditioning, November 1944.)

[2]Loc. Cit. Note 1.

For presentation at the 51st Annual Meeting of the American Society of Heating and Ventilating Engineers, Boston, Mass., January 1945.

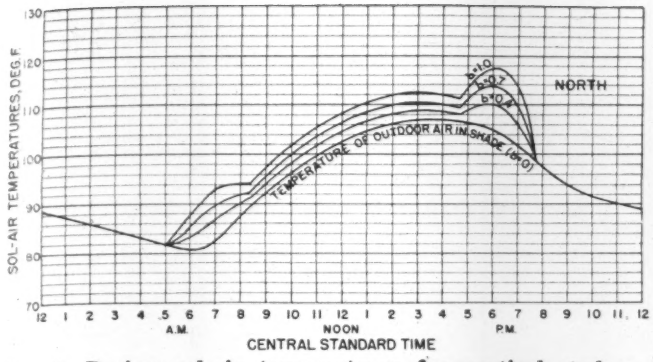


Fig. 2—Design sol-air temperatures for vertical surface facing North in Lincoln, Nebraska

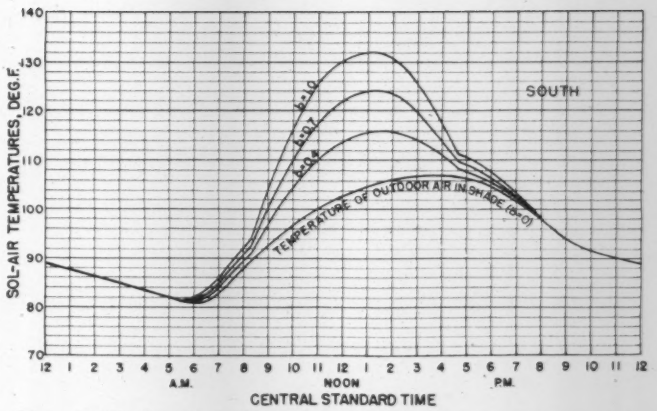


Fig. 4—Design sol-air temperatures for vertical surfaces facing South in Lincoln, Nebraska

of any orientation is one-half of that incident upon a horizontal surface at the same time of day. These two assumptions are not exactly true, and the sol-air temperatures for vertical surfaces are not precisely correct. Their effect upon the sol-air temperature, however, is not great, and the results are believed to be sufficiently accurate for the purpose of estimating the influence of heat transfer through building materials upon cooling load. This question is discussed at some length in the earlier paper.

Tables 1-5 and Figs. 1-5 are largely self-explanatory. Maximum temperatures and the temperatures equalled or exceeded only 5 per cent of the total hours in the ten-year period are tabulated for each hour of the day during each of the four months. For example, in Table 1, the maximum temperature of the outdoor air observed at 9 a. m. during the month of June (1932 through 1941) was 93 F, while in only 15 out of 300 readings at this hour did this temperature equal or exceed 87 F.

Although the average incident solar radiation is higher during June than July, the higher July air temperatures cause the sol-air temperatures to be higher in July than in any other month. This is generally true for the latitudes of Lincoln and New York. Consequently, the *design* value of the sol-air temperature at any given hour has been taken as that temperature equalled or exceeded only 16 times in 310 observations for the month of July in the ten-year period from 1932 through 1941. The same procedure was followed in obtaining design sol-air temperatures from the New York data.

Acknowledgment

The author gratefully acknowledges the cooperation of R. A. Dyke, Official in Charge of the Weather Bureau Station at Lincoln, and the help of Mr. Abbott Putnam, Instructor in Mechanical Engineering Laboratory at Cornell University, in obtaining and analyzing the data.

Appendix A

Wind Movement and Sol-Air Temperature

In calculating the sol-air temperatures of this report, a constant value of the outdoor air film coefficient of heat transfer of 4 Btu/hr ft² F has been used at each hour regardless of the actual wind velocity. According to the results of Rowley, Algren, and Blackshaw[4], this value is approxi-

[4]ASHVE Research Report No. 869—Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface, by F. B. Rowley, A. B. Algren, and J. L. Blackshaw. (ASHVE Transactions, Vol. 36, 1930, p. 429.)

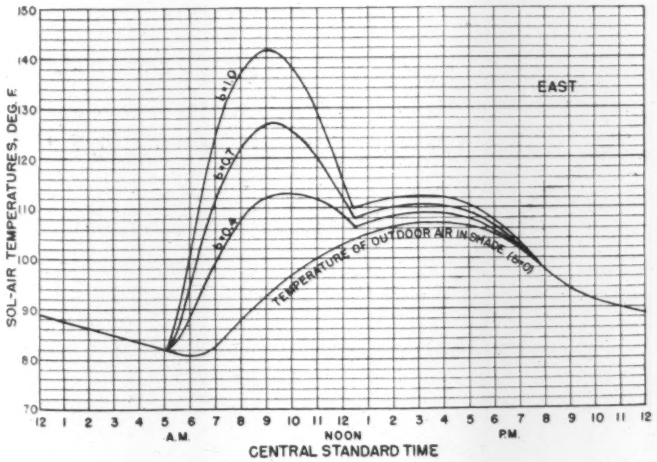


Fig. 3—Design sol-air temperatures for vertical surfaces facing East in Lincoln, Nebraska

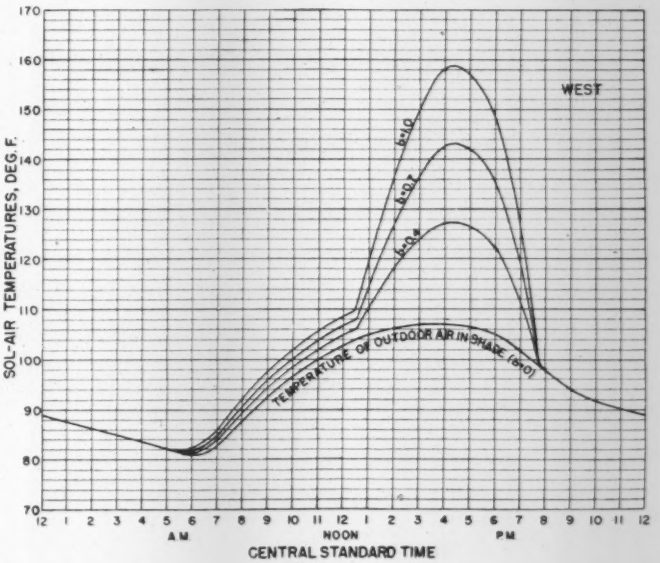


Fig. 5—Design sol-air temperatures for vertical surfaces facing West in Lincoln, Nebraska

Table 1—Outdoor Air Temperature Data—Lincoln, Nebr.

(Maximum hourly outdoor air temperature in the shade, and hourly outdoor air temperature equalled or exceeded on no more than 5 per cent of the days during a given month in the period from 1932 through 1941.)

Time of Day (C.S.T.)	Temperature of the Outdoor Air in the Shade, Degree F — Maximum — June	July	August	Sept.	Equalled or Exceeded Only 5 Per Cent of the Total Hours, 1932-1941 — June	July	August	Sept.
1 A.M.	87	98	92	87	81	88	84	81
2	87	96	90	85	81	86	83	80
3	88	94	89	84	79	84	82	80
4	87	92	89	84	79	84	81	78
5	85	91	88	82	77	82	80	77
6	84	91	86	82	77	81	80	76
7	84	93	86	85	79	82	80	75
8	88	95	89	87	82	88	84	80
9	93	99	94	90	87	93	88	83
10	95	103	98	92	90	96	92	87
11	99	106	103	95	93	100	96	90
12	101	109	105	98	96	102	99	92
1 P.M.	105	112	107	102	98	104	101	95
2	107	113	108	103	99	106	103	97
3	108	115	110	105	100	107	103	97
4	107	114	110	105	100	107	103	97
5	106	113	109	105	99	106	103	95
6	105	112	108	102	97	105	101	92
7	103	108	106	99	96	102	98	90
8	99	105	102	96	92	98	94	89
9	95	103	98	93	88	94	91	85
10	93	100	96	92	85	92	89	84
11	92	99	95	91	84	90	87	83
12	90	99	93	89	83	89	85	82
24-hour average of above	95.3	102.5	98.0	93.0	88.4	94.4	91.1	86.0

Table 2—Intensity of Total Solar and Sky Radiation on a Horizontal Surface—Lincoln, Nebr.

(Maximum hourly intensity, and hourly intensity equalled or exceeded on no more than 5 per cent of the days during a given month in the period from 1932 through 1941)

Time of Day (C.S.T.)	Intensity of Total Solar and Sky Radiation on Horizontal Plane, Btu/Hr Ft² — Maximum — June	July	August	Sept.	Equalled or Exceeded Only 5 Per Cent of the Total Hours, 1932-1941 — June	July	August	Sept.
5 A.M.	7	4	1	0	3	2	0	0
6	61	37	25	4	37	31	16	2
7	110	102	106	44	99	92	70	37
8	179	170	161	108	166	158	133	101
9	254	229	211	175	226	219	195	164
10	297	294	272	230	280	270	251	218
11	330	323	311	271	315	305	288	259
12	341	352	336	293	328	317	303	280
1 P.M.	348	356	332	295	333	320	306	283
2	328	337	322	281	317	308	286	263
3	285	293	270	242	275	270	247	220
4	247	230	217	188	225	218	196	167
5	176	169	157	117	166	163	137	106
6	110	110	88	47	101	96	71	38
7	67	50	31	10	41	37	18	4
8	16	11	4	0	7	5	2	0

Table 3—Maximum Sol-Air Temperature for Horizontal Surface in Lincoln, Nebr.

(Maximum values for 10-year period, 1932-1941.)

Time of Day (C.S.T.) (Solar Absorptivity)	Sol-Air Temperature, Degree F — June (1.0)	(0.7)	(0.4)	July (1.0)	(0.7)	(0.4)	August (1.0)	(0.7)	(0.4)	Sept. (1.0)	(0.7)	(0.4)
1 A.M.	87	87	87	98	98	98	92	92	92	87	87	87
2	87	87	87	96	96	96	90	90	90	85	85	85
3	88	88	88	94	94	94	89	89	89	84	84	84
4	87	87	87	92	92	92	89	89	89	84	84	84
5	86	85	85	91	91	91	88	88	88	82	82	82
6	92	89	87	96	94	93	88	88	87	83	82	82
7	106	99	93	106	102	98	103	98	93	95	92	89
8	126	115	103	132	121	110	125	114	103	114	106	98
9	146	130	114	154	137	121	141	127	113	129	117	106
10	165	144	123	172	151	130	157	139	122	147	131	114
11	177	153	130	182	159	136	171	150	130	157	139	120
12	180	156	132	185	162	139	176	154	133	165	145	125
1 P.M.	182	159	136	186	164	142	179	158	136	168	148	128
2	180	158	136	182	162	141	178	157	136	165	147	128
3	173	153	134	175	157	139	167	150	133	156	140	125
4	162	145	129	167	151	135	156	142	128	140	129	119
5	146	134	122	148	138	127	141	132	122	125	119	113
6	128	121	114	132	126	120	124	119	114	109	107	105
7	110	108	106	115	113	111	109	108	107	100	99	99
8	100	99	99	105	105	105	102	102	102	96	96	96
9	95	95	95	103	103	103	98	98	98	93	93	93
10	93	93	93	100	100	100	96	96	96	92	92	92
11	92	92	92	99	99	99	95	95	95	91	91	91
12	90	90	90	99	99	99	93	93	93	89	89	89
24-hour average of above	124.0	115.4	106.8	129.5	121.4	113.3	122.8	115.4	107.9	114.0	107.7	101.4

Table 4—Sol-Air Temperature for Horizontal Surface in Lincoln, Nebr.

(Equalled or Exceeded at Any Hour Only 5 Per Cent of the Total Hours in a Ten-Year Period, 1932-1941.)

Time of Day (C.S.T.) (Solar Absorptivity)	Design Sol-Air Temperature, Degree F — June (1.0)	(0.7)	(0.4)	July (1.0)	(0.7)	(0.4)	August (1.0)	(0.7)	(0.4)	Sept. (1.0)	(0.7)	(0.4)
1 A.M.	81	81	81	88	88	88	84	84	84	81	81	81
2	81	81	81	86	86	86	83	83	83	80	80	80
3	79	79	79	84	84	84	82	82	82	80	80	80
4	79	79	79	84	84	84	81	81	81	78	78	78
5	77	77	77	82	82	82	80	80	80	77	77	77
6	82	81	79	87	85	83	82	81	81	76	76	76
7	98	93	87	103	97	91	95	90	86	83	81	78
8	119	108	97	124	113	102	114	105	96	101	95	89
9	138	123	107	143	128	113	134	120	106	121	110	98
10	155	136	116	160	141	122	151	133	116	137	122	107
11	166	144	122	172	151	129	164	144	123	150	132	114
12	173	150	127	178	155	133	171	149	128	157	137	118
1 P.M.	176	153	129	180	157	134	173	151	130	161	141	121
2	173	151	129	178	156	135	170	150	130	157	139	121
3	165	145	126	170	151	132	161	144	126	148	132	117
4	151	136	120	158	143	127	149	135	121	133	122	112
5	135	124	114	142	131	120	133	124	115	117	111	104
6	119	113	106	126	120	113	116	111	107	99	97	95
7	104	101	99	109	107	105	101	100	99	90	90	90
8	92	92	92	99	98	98	94	94	94	89	89	89
9	88	88	88	94	94	94	91	91	91	85	85	85
10	85	85	85	92	92	92	89	89	89	84	84	84
11	84	84	84	90	90	90	87	87	87	83	83	83
12	83	83	83	89	89	89	85	85	85	82	82	82
24-hour average of above	116.0	107.7	99.5	121.6	113.4	105.3	115.2	108.1	100.8	106.3	100.2	94.1

Table 5—Sol-Air Temperatures for Vertical Surfaces in Lincoln, Nebr. ***(Equalled or Exceeded at Any Hour in July only 5 Per Cent of the Total Hours in a Ten-Year Period, 1932-1941).***

Time of Day (C.S.T.) (Solar Absorptivity)	Design Sol-Air Temperature, Degree F — Surface Facing											
	North			East			South			West		
	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)	(1.0)	(0.7)	(0.4)
1 A.M.	88	88	88	88	88	88	88	88	88	88	88	88
2	86	86	86	86	86	86	86	86	86	86	86	86
3	84	84	84	84	84	84	84	84	84	84	84	84
4	84	84	84	84	84	84	84	84	84	84	84	84
5	82	82	82	82	82	82	82	82	82	82	82	82
6	88	87	84	100	95	89	82	82	82	82	82	82
7	93	90	87	125	112	99	85	84	83	85	84	83
8	94	92	91	137	122	108	92	91	90	92	91	90
9	98	97	95	142	127	112	104	101	97	98	97	95
10	102	100	98	138	126	113	115	110	104	102	100	98
11	106	104	102	129	120	112	125	118	110	106	104	102
12	108	106	104	115	111	107	130	122	113	108	106	104
1 P.M.	110	108	106	110	108	106	132	124	115	119	115	110
2	112	110	108	112	110	108	131	123	116	137	128	118
3	113	111	109	113	111	109	126	120	114	150	137	124
4	112	111	109	112	111	109	117	114	111	158	143	127
5	113	111	109	110	109	108	110	109	108	157	141	126
6	117	114	110	108	107	106	108	107	106	149	136	123
7	113	110	107	104	103	103	104	103	103	128	120	112
8	98	98	98	98	98	98	98	98	98	98	98	98
9	94	94	94	94	94	94	94	94	94	94	94	94
10	92	92	92	92	92	92	92	92	92	92	92	92
11	90	90	90	90	90	90	90	90	90	90	90	90
12	89	89	89	89	89	89	89	89	89	89	89	89
24-hour average of above	98.6	97.4	96.1	105.9	102.5	99.0	102.1	99.8	97.5	106.6	102.9	99.3

Table 6—Direct Solar Radiation Ratios at Lincoln, Nebr. (Calculating Table) ***(Solar declination of 21° 36', Mid-July)***

Time (C.S.T.)	Ratio: Direct Solar Radiation on Vertical Surface to Direct Solar Radiation on Horizontal Surface — Vertical Surface Facing			
	North	East	South	West
6 A.M.	2.215	5.844		
7	0.5600	2.693		
8	0.07435	1.648		
9		1.080	0.1447	
10		0.6916	0.2600	
11		0.3853	0.3200	
12 noon		0.1163	0.3462	
1 P.M.			0.3449	0.1424
2			0.3156	0.4138
3			0.2508	0.7257
4			0.1286	1.1260
5	0.1059			1.722
6	0.6405			2.855
7	2.617			6.584

Table 7—Solar Altitude at Lincoln, Nebr. (Calculating Table)

Time (C.S.T.)	Solar Altitude — North Latitude of 40°50' West Longitude of 96°45' Solar Declination of 21°36'	
5:07 A.M.	0°	(Sunrise)
6:00	9° 5'	
7:00	19° 59'	
8:00	31° 13'	
9:00	42° 33'	
10:00	53° 33'	
11:00	63° 24'	
12:00 noon	69° 56'	
1:00 P.M.	69° 32'	
2:00	62° 30'	
3:00	52° 29'	
4:00	41° 25'	
5:00	30° 5'	
6:00	18° 52'	
7:00	8° 2'	
7:47	0°	(Sunset)

mately correct for a *parallel* movement of air past a surface (mean temperature of surface and air of 80 F) when the wind velocity is 5 mph with a brick or concrete surface (rough), and 10 mph for a glass or painted wood surface (smooth).

The hourly wind movement observed during the month of July at Lincoln, Nebr., over a five-year period is summarized in Table A-1.

Table A-1—Hourly Wind Movement Observed During Month of July at Lincoln, Nebr., Over Five-Year Period

Year	Average Hourly Wind Movement in Miles During July for Hour Ending — 9 A.M.	Noon	3 P.M.
1932 (31 readings)	10.5	10.2	11.1
1933 (31 readings)	8.5	9.1	9.6
1934 (31 readings)	10.3	11.6	11.8
1935 (31 readings)	9.0	10.1	11.2
1936 (31 readings)	10.3	11.8	11.9
1932-1936 (155 readings)	9.7	10.5	11.1

The *maximum* hourly wind movement observed in the same period was 19 miles for the hour ending at 9 a. m., 22 miles for the hour ending at 12 noon, and 20 miles for the hour ending at 3 p. m. The minimum hourly wind movement observed at Lincoln, Nebr., in July during the same period was 3 miles for the hours ending at 9 a. m. and at 12 noon, and 4 miles for the hour ending at 3 p. m.

A slight tendency was observed for the higher values of the total solar and sky radiation to occur simultaneously with the higher wind velocities. This effect, however, is not invariable. For example, the solar and sky radiation incident upon the horizontal was 352 Btu/hr ft² on July 21, 1933, while the wind velocity was 7 mph for the hour ending at 12 noon; on July 5, 1933, the solar and sky radiation incident upon the horizontal for the same hour was 341 Btu/hr ft² with a wind velocity of 16 mph.

Although the value of the outdoor air film coefficient of heat transfer used in calculating the sol-air temperature from weather data should vary with the instantaneous wind velocity for perfection, this procedure is complicated. In the light of the above facts, the procedure of using a constant value of 4 for this coefficient will yield reasonably reliable values that will, in general, be on the safe side when used for estimates of cooling loads.

Appendix B

Comparison of Sol-Air Temperatures in New York, N. Y., and Lincoln, Nebr.

The sol-air temperatures that were equalled or exceeded only five per cent of the total hours during July in the ten-year period from 1932 through 1941 are used as *design* values; *average* daily design values may be compared for New York and Lincoln (see Table B-1).

The average daily design sol-air temperatures in Lincoln, Nebr., are from 9.6 F to 15.2 F higher than the corresponding temperatures in New York, N. Y.; the actual difference depends upon the orientation of the surface and its solar absorptivity.

Since the latitudes of these two cities are nearly the same, the sol-air temperature *vs.* time of day curves have about the same shape. One way of comparing these shapes for a given orientation and absorptivity is to compare the ratios of the difference between the sol-air temperature at a given time and the average daily sol-air temperature, to the daily range in the sol-air temperature. Such a comparison appears in Table B-2 for a horizontal surface with a solar absorptivity of 0.7.

On a coordinate system with the ratio of the difference between the

Table B-1—Comparison of Average Daily Design Values for July in New York and Lincoln

Design Sol-Air Temperatures, F	New York, N. Y.	Lincoln, Nebr.
Average daily outdoor air in shade (b = 0)	84.8	94.4
Average daily temp. for horizontal surface (b = 0.4)	93.2	105.3
Average daily temp. for horizontal surface (b = 0.7)	99.8	113.4
Average daily temp. for horizontal surface (b = 1.0)	106.4	121.6
Average daily temp. for vertical surface facing N (b = 0.4)	86.2	96.1
Average daily temp. for vertical surface facing N (b = 0.7)	87.3	97.4
Average daily temp. for vertical surface facing N (b = 1.0)	88.5	98.6
Average daily temp. for vertical surface facing E (b = 0.4)	87.8	99.0
Average daily temp. for vertical surface facing E (b = 0.7)	89.9	102.5
Average daily temp. for vertical surface facing E (b = 1.0)	92.3	105.9
Average daily temp. for vertical surface facing S (b = 0.4)	87.1	97.5
Average daily temp. for vertical surface facing S (b = 0.7)	89.0	99.8
Average daily temp. for vertical surface facing S (b = 1.0)	90.7	102.1
Average daily temp. for vertical surface facing W (b = 0.4)	89.5	99.3
Average daily temp. for vertical surface facing W (b = 0.7)	93.0	102.9
Average daily temp. for vertical surface facing W (b = 1.0)	96.5	106.6

Table B-2—Comparison of Ratio: Difference Between the Sol-Air Temperature at a Given Time and the Average Daily Sol-Air Temperature, to the Daily Range in the Sol-Air Temperature

Time of Day	Design Sol-Air Temperature, t_e New York, N. Y.	Design Sol-Air Temperature, t_e Lincoln, Nebr.	Ratio: $\frac{t_e - t_m}{\text{Range of } t_e}$ New York, N. Y.	Ratio: $\frac{t_e - t_m}{\text{Range of } t_e}$ Lincoln, Nebr.
1 A.M.	78	88	—0.35	—0.34
2	77	86	—0.38	—0.37
3	77	84	—0.38	—0.39
4	76	84	—0.40	—0.39
5	76	82	—0.40	—0.42
6	79	85	—0.35	—0.38
7	92	97	—0.13	—0.22
8	102	113	+0.04	0.00
9	114	128	0.24	+0.20
10	122	141	0.37	0.37
11	130	151	0.50	0.50
12 noon	135	155	0.59	0.56
1 P.M.	136	157	0.60	0.58
2	124	156	0.57	0.57
3	129	151	0.49	0.50
4	123	143	0.38	0.40
5	112	131	0.20	0.23
6	101	120	0.02	0.09
7	91	107	—0.15	—0.08
8	85	98	—0.25	—0.20
9	83	94	—0.28	—0.26
10	82	92	—0.30	—0.29
11	81	90	—0.31	—0.31
12	79	89	—0.35	—0.33
24-hour average, t_m	99.8	113.4		
Daily range, Δt_e	60	75		

sol-air temperature at a given time and the daily average sol-air temperature to the daily range in sol-air temperature $\left(\frac{t_e - t_m}{\Delta t_e}\right)$ plotted against time of day, one curve will closely fit the results observed at Lincoln and at New York for a given orientation and solar absorptivity of the surface. Latitude, however, would be expected to have an effect upon the shapes of these curves; in other words, corresponding curves for New Orleans, for example, would probably not have the same shape.

The effect of the greater sol-air temperature in Lincoln, Nebr., upon the maximum rate of heat flow through a typical wall is next shown by an example. Assume a homogeneous, vertical, west wall made of 8 in. of brick with a solar absorptivity of the outside surface of 0.7. By the approximate method of solution which uses a decrement factor and time lag that are the arithmetic means of the values for the fundamental and second harmonic[5], the average decrement factor for this wall is:

$$\lambda = \frac{0.15 + 0.08}{2} = 0.115,$$

and the average time lag is:

$$\phi = \frac{\frac{83}{15} + \frac{131}{30}}{2} = 5.0 \text{ hour}$$

For this west wall, the maximum design sol-air temperature in *New York, N. Y.*, is 129 F at 4:00 p. m. Consequently, for a constant temperature of the indoor air of 80 F, the maximum temperature of the inside surface of this wall would be 87.4 F at 9:00 p. m.; the corresponding maximum rate of heat transfer at the indoor surface is *12.2 Btu/hr ft²*. In *Lincoln, Nebr.*, the maximum design sol-air temperature for this wall is 143 F at 4:24 p. m.; for a constant temperature of the indoor air of 80 F, the maximum temperature of the inside surface of this wall would be 90.3 F at 9:24 p. m., and the maximum rate of heat transfer is *17.0 Btu/hr ft²*. In the case of this one wall, the greater sol-air temperatures at Lincoln, Nebr., cause the maximum rate of heat transfer to be 40 per cent higher than in New York, N. Y. The principal reason for this is the greater daily average design sol-air temperature for this surface in Lincoln (102 F *vs.* 93.0) rather than the greater daily range in design sol-air temperature (61 F *vs.* 54 F). If the temperature of the indoor air were held constant at 80 F for 24 hours, the quantity of heat transmitted daily through one square foot of this same wall would be 224 Btu in Lincoln as against 127 Btu in New York on the design day. The *maximum* rate of heat transfer affects the required capacity of the cooling unit, but the *daily* rate of heat transfer affects the daily energy consumption of that unit.

The sol-air temperature study would seem to indicate that the load on the cooling equipment in Lincoln, Nebr., and the energy consumption for the design conditions, insofar as they are affected by solar radiation and air temperature, only, in maintaining a constant temperature of the indoor air of 80 F are substantially the same as if a constant indoor air temperature of 70 F were to be maintained in New York, N. Y.

[5]Periodic Heat Flow-Homogeneous Walls or Roofs, by C. O. Mackey and L. T. Wright, Jr. (ASHVE Journal Section, *Heating, Piping & Air Conditioning*, September 1944.)

Appendix C

Other Sol-Air Temperatures in U.S.A.

Design sol-air temperatures have now been found by the same method for Lincoln, Nebr., and for New York, N. Y. In *Monthly Weather Review*, April, 1941, Dr. I. F. Hand gives interesting data on the measurement of total solar and sky radiation. Some of the pertinent results given in this reference or derived from it are presented.

The departure of the average total solar and sky radiation received daily at each station in a given band of latitudes from the composite for that band follows:

35°-45° N. Latitude—(Composite of 8 stations for week beginning July 2)

	Per Cent
Fresno, Cal.	+25.2
Washington, D. C.	— 5.1
New York, N. Y.	— 5.4
Lincoln, Nebr.	+ 3.9
Chicago, Ill.	—19.0
Blue Hill, Mass.	+ 3.3
Twin Falls, Idaho	— 3.4
Madison, Wis.	+ 0.1

Table C-1—Pyrheliometric Stations in U. S. A.
(Arranged in Order of Latitudes)

Station	Under Direction of	N. Lat. Deg	N. Lat. Min	W. Long. Deg	W. Long. Min	Altitude, Ft
San Juan, P. R.	U.S.W.B.	18	28	66	06	85
Miami, Fla.	Dr. O. J. Sieplein	25	41	80	12	50
New Orleans, La.	Tulane University	29	56	90	07	100
LaJolla, Cal.	Scripps Inst. of Oceanography	32	50	117	15	85
Riverside, Cal.	University of California	33	58	117	28	1051
Fresno, Cal.	U.S.W.B.	36	43	119	49	330
Washington, D. C.	U.S.W.B.	38	56	77	05	397
New York, N. Y.	U.S.W.B.	40	46	73	58	180
Lincoln, Nebr.	U.S.W.B.	40	50	96	45	1225
Chicago, Ill.	U.S.W.B.	41	47	87	25	688
Blue Hill, Mass.	Harvard	42	13	71	07	640
Twin Falls, Idaho	U. S. Bureau of Entomology	42	29	114	25	4300
Madison, Wis.	U.S.W.B.	43	05	89	23	974
Friday Harbor, Wash.	University of Washington	48	32	123	01	15
Fairbanks, Alaska	U.S.W.B.	64	52	147	39	500

Table C-2—Mean Hourly Totals of Solar and Sky Radiation for Week Beginning July 2

(Received on a Horizontal Surface for Stations at North Latitudes Between 35 deg and 45 deg—Apparent Solar Time)

Station	Btu/Ft² for Hour Ending A.M. 6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	Total 6 A.M.-7 P.M.
Fresno (1936-39) ...	26	89	159	218	266	299	318	318	292	255	210	151	81	26	2708
Washington (1927-39) ...	21	66	115	159	197	224	242	240	231	204	153	112	65	24	2053
New York (1936-39) ...	30	74	111	162	207	229	229	229	222	192	159	114	66	22	2046
Lincoln (1925-39) ...	22	66	122	173	214	247	266	266	255	218	173	126	74	26	2248
Chicago (1923-39) ...	20	54	94	134	167	188	198	204	198	167	144	103	59	22	1752
Blue Hill (1936-39) ...	30	74	125	170	218	247	266	269	251	206	173	118	66	22	2235
Twin Falls (1936-39) ...	33	74	118	159	195	229	240	244	214	188	159	122	81	33	2089
Madison (1936-39) ...	22	66	118	155	199	244	258	266	247	214	173	118	70	26	2176
Average for 8 Stations ..															2163

Table C-3—Mean Hourly Totals of Solar and Sky Radiation

(Received on a Horizontal Surface for Week Beginning as Indicated for Stations at North Latitudes between 25 deg and 35 deg—Apparent Solar Time)

Station	Btu/Ft² for Hour Ending A.M. 6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	Total 6 A.M.-7 P.M.
Miami (1936-38) (June 4)	4	30	78	136	184	206	232	236	225	192	162	111	63	26	1885
New Orleans (1936-39) (June 11) ...	7	44	103	159	206	240	262	258	218	177	137	103	52	22	1988
La Jolla (1936-39) (June 4)	15	44	96	151	214	269	295	291	273	229	170	111	70	11	2239
Riverside (1936-39) (June 11)	11	55	107	166	214	258	280	276	258	225	181	122	59	15	2227
Average for 4 Stations ..															2085

25°-35° N. Latitude—(Composite of 4 stations for week beginning June 4 or June 11)

	Per Cent
Miami, Fla.	— 9.6
New Orleans, La.	— 4.7
La Jolla, Cal.	+ 7.4
Riverside, Cal.	+ 6.8

The departure of the average daily solar and sky radiation received during the entire year from the composite for ten stations follows:

	Per Cent
Miami, Fla.	+ 9
New Orleans, La.	+ 2
[a]La Jolla, Cal.	+16
[a]Riverside, Cal.	+14
[a]Fresno, Cal.	+29
[a]Washington, D. C.	— 5
[a]New York, N. Y.	—16
[a]Lincoln, Nebr.	+ 4
[a]Chicago, Ill.	—24
Blue Hill, Mass.	— 5
[a]Twin Falls, Idaho	+ 4
[a]Madison, Wis.	— 5

[a]These stations and Friday Harbor were included in the composite.

Except for Fresno, where there is an exceedingly high percentage of sunshine (San Joaquin Valley), and Chicago, where very smoky conditions prevail near the station, the departure of each station from the average is not very great.

There may be a correlation between design sol-air temperatures and these departures, but data have not been secured from enough cities to check this. It has been pointed out that the difference between average daily design sol-air temperatures in Lincoln, Nebr., and New York, N. Y., is about 10 F for all orientations and solar absorptivities. Based on the average radiation incident upon the horizontal for the week of July 2, 9.3 percentage points separate Lincoln and New York in the departure table; based on the average radiation received during the entire year, 20 percentage points separate the same two stations in the departure table. Whether the correlation, if any, is between design sol-air temperature and summer departure or annual departure may only be found from more data.

It is proposed to obtain data for the month of July from two more stations, Washington and Chicago, and for the months of June, July, and August from one station in the lower band of latitudes, perhaps New Orleans, if the Committee deems this desirable. It no longer seems necessary to analyze the data for four months as was done in Lincoln and New York, and this will cut down on the time required for the study.

NEWTON APPOINTED CHIEF ENGINEER OF AIRTEMP

A. B. Newton has been appointed Chief Engineer, Airtemp Division, Chrysler Corp., Dayton, Ohio, succeeding A. P. Livar who has resigned to become associated with a non-competing company in the East. Mr. Newton was formerly Staff Engineer in charge of commercial refrigeration.

Before coming to Airtemp, Mr. Newton was manager of the Refrigeration Control Division, Minneapolis-Honeywell Regulator Co. and was with that company for eight years. Previous to that he was associated with York Ice Machinery Corp., for five years in its development and engineering departments, and with General Electric Company for two years doing turbine research and centrifugal refrigeration work. Mr. Newton is a native of New England, and he attended Syracuse University after which he did graduate work at the Massachusetts Institute of Technology.

J. F. STONE ELECTED PRESIDENT OF ASRE

At the close of its 40th annual meeting, held Dec. 10-13, 1944, at the Hotel Pennsylvania in New York, N. Y., results of the election of officers for the *American Society of Refrigerating Engineers* for the coming year were announced as follows:

President—J. F. Stone, manager of refrigeration division, Johns-Manville Corp., New York, N. Y.

Vice President—Charles S. Leopold, consulting engineer, Philadelphia, Pa.

Vice President—Roland H. Money, chief refrigeration engineer, The Crosley Corp., Cincinnati, Ohio.

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A Survey of Testing Methods and Rating Limits for Domestic Heating Devices†

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SUMMARY—Factors which determine test methods for heating appliances and which serve to limit ratings are summarized by the author. The various Codes and Commercial Standards which have gained general acceptance are enumerated, and brief summaries of significant features are included. A table of the most important features is provided for ready reference.

THERE HAS been considerable progress in the formulation of testing and rating methods for heating devices during the past several years, much of which has been due to the interest of the various housing agencies of the Government. It is generally agreed that economy can be gained by installing heating devices or systems more nearly suitable in capacity for the houses they are to serve, than have been used in a large number of cases heretofore and interest in standards has increased because equipment and man-hours can be saved by reducing the number of kinds or sizes of heating devices manufactured. This is particularly important during the war period.

Introduction

A survey or summary such as this may serve a useful purpose in affording an over-all view of testing methods and rating limits, but it is not to be presumed that this paper constitutes a criticism of any device or test method or that the purpose is to show how one class of devices suffers in comparison with another. For instance, the fact that a coal stove may have a required efficiency lower than that of some gas burning device is no reason why the stove should never be used. Gas is a highly refined fuel and high combustion efficiencies with it are to be expected, but in some regions gas is much more expensive per Btu than coal (or other fuels). For this reason, many people will continue to use coal stoves. These considerations indicate, if carried further, that a variety of equipment should be available, in order to permit flexibility in utilization, and standards for each type of equipment appear to be in order. These standards rightly have been based for the most part on performance. The objective is, and should be, to define the purpose of a device and leave it to the manufacturer or inventor to develop the best possible type.

Commercial Standards are based on a consensus of all interested parties including manufacturers, distributors, and users. The Trade Standards Division of the *National Bureau of Standards* is maintained to facilitate better understanding within the entire trade. More governmental influence than usual has been exerted toward standardization during the war period.

Testing methods and rating limits for a number of coal and oil burning domestic heating devices have been incorporated in Commercial Standards and Trade Standards, published by the National Bureau of Standards, within the last few years. These testing methods and rating limits have, therefore received consideration by representatives of the interested industries, as well as by representatives of consumers including the Government agencies. This is not to say that these testing methods and rating limits have received universal approval but at least they have received considerable support among the groups mentioned.

Some branches of the industry have established and have maintained their own standards for a long time so that some items are covered by industry standards and not by Commercial Standards promulgated by the *National Bureau of Standards*. Chief among these are heating boilers and gas-burning devices in general. Probably the testing methods and rating limits contained in the code of the *Institute of Boiler and Radiator Manufacturers* are more widely used at the present time than any others for heating boilers, except gas burning boilers. Gas burning boilers and other heating devices are covered by the Approval Requirements for Central Heating Gas Appliances, sponsored by the *American Gas Association*, and approved by the *American Standards Association*.

Tests of devices for compliance with Commercial Standards (published by the *National Bureau of Standards*) are conducted in laboratories either maintained or chosen by the manufacturers. Very often an effort is made to simplify the specified testing procedure in order to minimize the trouble and expense to manufacturers who wish to conduct their own tests.

The rating limits for various classes of equipment have been tabulated in Fig. 1. For the reason that some of the figures given may not be comparable with each other, on account of differences in test methods, a more complete statement of the test methods and requirements for various devices is given as follows:

Domestic Burners for Pennsylvania Anthracite (Underfeed Type)

*Commercial Standard — CS*48-40: According to this Commercial Standard, anthracite stokers are installed for test in a round, sectional, cast-iron boiler, having three intermediate sections, insulated with 1½ in. of asbestos or equivalent. The stoker is tested at 50 per cent or more of boiler capacity at some fuel rate exceeding 50 per cent of its maximum for some period exceeding 4 hours. Under this condition, the over-all efficiency of the stoker and boiler is required to exceed 50 per cent, the ash loss is limited to 7½ per cent and the carbon dioxide content of the flue gas must be 7½ per cent, or more, by volume. The combustion rate is required to be at

Fig. 1—Rating Limits of Domestic Heating Devices

†Approved by *National Bureau of Standards Editorial Committee.*

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FIG. 1—Rating Limits of Domestic Heating Devices

Device	Source or Publication	Test Fuel	Stack: Max Temp Fahr	Stack: Min CO_2 %	Min Efficiency %	Max Draft in. Water	Smoke	Special Requirements	Test Method and Remarks
Anthracite burner (domestic stoker)	CS 48-40[a]	Anthracite buckwheat No. 1 or No. 2	.....	7.5	50	.....	.....	Ash loss limited to 7.5 per cent or less. Endurance test of 300 hrs required. Rating is 90 per cent of output under test. Piping and pick-up allowance: 25 per cent.	Test in insulated, round, cast-iron boiler for efficiency, etc. Pick-up in 60 min from banked fire is required.
Oil burners (automatic mechanical draft)	CS 75-42	Heaviest approved by Underwriters Laboratories	.....	10.0	....	0.03 to 0.05 in comb'n ch'mb'r	.....	Required CO_2 in flue gas: 10 per cent in laboratory, 8 per cent in field. Smoke test apparatus described in Underwriters Laboratories, Inc., std., for dom. oil burners. (Subject 296).	Test in suitable boiler. Draft allowed over fire: 0.03 in. water for capacities less than 5 gph. 0.05 in. water for capacities of 5 gph or more.
Gas floor furnaces	CS 99-42	.....	.....	.....	....	.....	.....	No test specified. Standard covers construction and installation. Compliance with American standard approval requirements for central heating gas appliances Z 21.13 is required. For sizing, a 10 per cent pick-up factor is applied.	
Space heaters (flue connected; with pot-type oil burners)	CS 101-43	No. 1 fuel oil (See CS 12-40 "Fuel Oils")	920 plus room	.....	70 at 0.06 draft	0.08 in flue	6%[b] ICHAM	Low fire fuel rate not more than 0.7 lb/hr or 25 per cent of high fire rate, whichever is greater. Minimum draft 0.02 in. water.	Output determined by indirect test. Smoke evaluated by method of *The Institute of Cooking and Heating Appliance M'f'rs.*
Warm air furnaces with pot-type oil burners	CS (E) 104-43	Heaviest recommended by manufacturer						Maximum air temp rise gravity furnaces, 160 deg F. Allowable air temp rise for fan furnaces; 90 ± 10 deg F. Maximum draft; 0.06 in. water for natural draft furnaces or 0.04 in. water for forced draft furnaces; not less than 0.02 in. water for either.	Either direct or indirect test device — Flue gas temp deg F above room
Gravity circulation	.....		.....	10	70	.....	10% ICHAM		Forced draft furnaces: 780
Forced circulation	.....		.....	10	72	.....			Natural draft furnaces: 300 to 800
									Gravity: 300 to 920
Forced air furnaces (solid fuel burning)	CS 109-44	Anthracite chestnut	830 plus room	.....	55	0.06	.....	Attention interval: 8 hrs or more for surface fired, or 12 hrs or more for magazine feed furnaces. Outlet air temp; 70 to 100 deg F above room temp. Banking period: At least 12 hrs for surface fired and 24 hrs for magazine furnaces.	Output determined by direct test with bonnet pressure of 0.2 in. water without air filters. Heat exchanger temp limited to 830 deg F above room average and 930 deg F above room maximum.
Floor furnaces (pot-type oil burners)	CS 113-44	Heaviest recommended by m'f'r	780 plus room	10	70	0.02 to 0.06	6% ICHAM	Low fire fuel feed rate: 25 per cent or less of high fire rate. Flue gas temp: 300 to 780 deg F above room for high fire.	Output determined by indirect test. A 10 per cent pick-up factor is applied for installation.
Coal burning space heater (with or without jackets)	TS-3443[c]	Anthracite chestnut						For surface fired heater: Attention interval: 6 hrs, banking period: 12 hrs; for magazine heater: Attention interval 12 hrs, banking period, 24 hrs. Heat exchanger temp limited to 1000 F or lower than red heat.	Output determined by indirect test. Jacket temp limited to 400 F except near door frame or flue collar.
Surface fired	.....	.....	900	.....	55	0.06	.....		
Magazine feed	.....	.....	900	.....	50	0.06	.....		
Hot water supply boilers (hand fired)	TS-3560[c]	Anthracite chestnut or stove	.....	.....	....	.....	.....	Draft adjusted to simulate chimney action according to a curve. Rating is based on 6-hr firing period. Ratings are expressed in gallons of water per hour heated 100 deg F.	Direct test. Discharged water at 150 ± 20 F. Boilers up to 75 gpm capacity are mounted on weighing scale for test to facilitate observation of combustion rate.
Heating boilers (hand fired)	I=B=R Code[d]	Anthracite stove or size specified by manufacturer	.....	.....	58	.....	.....	Draft adjusted to simulate chimney action for observed flue gas temps. Attention interval: 4 to 7.5 hrs; piping and pick-up factor: 1.60 to 2.36. These factors vary inversely as boiler size.	Steam is condensed and weighed for boilers of less than 1,000,000 Btu per hr of capacity. For larger boilers, feed water may be weighed. This applies to mechanically fired boilers also.
Mechanically fired	I=B=R Code	No. 2 fuel oil or as specified for special burners	600	10	68	0.02 in fire box	.....	Piping and pick-up factor: 1.34 to 1.56. Factor varies inversely with boiler size.	Test with high pressure atomizing burner unless designed for another type.
Gas burning appliances	Approval requirements for central heating appliances[e]	Natural or manufactured gas or propane, butane or butane-air mixtures, in accord with design							
Steam boilers				.....	75	.....	.....	Test at atmospheric pressure. Required steam quality: 97 per cent.	Direct test. Feed water weighed.
Hot water boilers			480	.....	75	.....	.....	Test with discharged water at 180 ± 2 F.	Direct test. Calorimetric method.
Warm air furnaces			plus					Air temp rise, without automatic cut off: 160 deg F. Automatic cut off, if used, must function at 250 F.	Direct test. Air delivery and temp rise are measured.
Gravity	.....		room	.....	70	.....	.....		
Forced	.....			.....	75	.....	.....	Discharge air temp: 70 to 100 deg ± 2 deg F above room temp.	Direct test, as above. Heating element temp limited to 875 F for either gravity or forced furnaces.
Floor furnaces									
Gravity	.....	.....	530 plus room	.....	65	.....	.....	Air temp limited to 350 deg F above room temp one inch above grille.	Direct test, as above.
Forced	.....	.....		.....	70	.....	.....		

[a] CS = Commercial standard. Promulgated by *The National Bureau of Standards.* Available from the Government Printing Office, Washington, D. C.
[b] ICHAM = *Institute of Cooking and Heating Appliance Manufacturers.*
[c] TS = Trade Standards Division. (These proposed commercial standards in process of development).
[d] I = B = R = Institute of Boiler and Radiator Manufacturers.
[e] Requirements approved by the *American Standards Association,* sponsored by *The American Gas Association.*

least 13 lb per hour per square foot of horizontal projected area of the firepot, including the ash ring, and such operation must be maintained at least nine hours. The test is made with anthracite No. 1 buckwheat, or No. 2 buckwheat unless the stoker is especially designed for other fuels. The electric energy consumption is limited to 18 kw hours per short ton of coal burned when the stoker is operated at 59 per cent or more of maximum rating. Controls are required such that the stoker will maintain a fire indefinitely and that, when the stoker resumes operation after a 12-hour banking period, the time required for the stack temperature to reach normal shall not exceed 60 min.

Automatic Mechanical-Draft Oil Burners Designed for Domestic Installations

*Commercial Standard CS*75-42: According to this Commercial Standard, oil burners of the type mentioned are required to be capable of producing 10 per cent CO_2 in the flue gas during a laboratory test and 8 per cent CO_2 in the flue gas in field installations.

Oil burner testing apparatus is maintained by the Underwriters' Laboratories, Inc., Chicago, which includes means for testing these devices for radio interferences and for smoke production. The smoke testing apparatus is described in Underwriters' Laboratories, Incorporated, Standard for Domestic Oil Burners (Subject 296).

For testing, the burner is mounted in a suitable boiler and is operated on the heaviest oil recommended for it by the Underwriters' Laboratories, Inc.; the draft must not exceed 0.03 in. water for burners tested at 5 gal of oil per hour or less, nor exceed 0.05 in. water for burners tested at more than 5 gal of oil per hour.

Flue-Connected Oil Burning Space Heaters Equipped with Vaporizing Pot-Type Burners

*Commercial Standard CS*101-43: According to the provisions of this Commercial Standard, heaters of the type covered are set up for test in a standard Underwriters' booth or so-called *black corner*. The efficiency and output are based on flue gas analysis and temperature and fuel burning rate. The heater is required to develop an efficiency of 70 per cent or more when operated with 0.06 in. of draft or at a draft recommended by its manufacturer except that the draft must not be less than 0.02 in. or more than 0.08 in. water during the test. Smoke produced is required to be 6 per cent or less by the *Institute of Cooking and Heating Appliance Manufacturers'* test. It is required that unburned fuel gases shall not occur in the flue products in sufficient quantities to be measurable by recognized methods as unburned gas or vapor in excess of 0.2 per cent by volume or to result in failure of the observed CO_2 and O_2 values to check by more than 0.3 per cent. Stack temperature during the high fire test is limited to 920 F above room temperature. The test fuel is not heavier than Commercial Grade No. 1 oil (*Commercial Standard CS*12-40). *High fire* is an oil burning rate at 0.06 in. draft or at a draft recommended for high fire by the manufacturer. *Low fire* is defined for manually operated heaters as a burning rate of 0.7 lb of fuel per hour or less or not in excess of 25 per cent of the high fire rate, whichever is greater. Thermostatically operated heaters on pilot fire and manually operated heaters on low fire are required to meet the requirement for smoke specified for high fire.

This Commercial Standard contains a field test table, to be used as a basis for judging the acceptability of the performance of installed heaters, based on flue gas temperature and CO_2 content.

Also incorporated is a table of altitude correction factors for use in predicting the capacities of heaters at various altitudes up to 7000 ft above sea level.

Warm Air Furnaces Equipped with Vaporizing Pot-Type Oil Burners

Commercial Standard (*Emergency*) *CS*(*E*)104-43: This Commercial Standard covers both gravity flow and forced circulation furnaces with either natural or mechanical draft.

A forced circulation furnace is set up for test in accord with its manufacturer's instructions, with air filter and humidifier in place, if the design includes them. The humidifier, if present, is left dry for the test. The furnace is then equipped with testing equipment including a discharge duct with a damper and, during the test, the bonnet pressure is regulated in accord with the following table.

Air Delivery (Cfm)	External Static Pressure (In. Water)
0 to 800	0.12
over 800 to 1600	0.20
over 1600 to 3000	0.24
over 3000 to 6000	0.30

The fuel-burning rate is adjusted to give an air temperature rise of 90 ± 10 F.

At maximum output the draft is required not to exceed 0.04 in. water for mechanical draft furnaces or 0.06 in. water for natural draft furnaces and to be not less than 0.02 in. water for either. The flue gas temperature must be between 300 F and 880 F above room temperature for natural draft burners and not more than 780 F above room temperature for mechanical draft burners. The CO_2 in the flue gas must be at least 10 per cent and smoke is limited to 10 per cent by the *ICHAM* test.

The efficiency and output may be determined by either the direct or the indirect method. When the direct method is used, either the test specified in *American Society of Refrigerating Engineers'* Circular No. 16,[1] (Standard Methods of Testing and Rating Self-Contained Air Conditioning Units for Comfort Cooling) or another wind tunnel method, approved by the manufacturers' representatives on the standing committee, may be used. When the indirect method is used, the observed efficiency and output are termed gross efficiency and gross output. The gross efficiency is required to be at least 70 per cent for gravity furnaces and 72 per cent for forced-air furnaces. Bonnet capacity is found by deducting 5 per cent from the gross output.

Gravity furnaces are set up for test and fitted with 8, 10 or 12 in. leader pipe collars having an aggregate area not greater than

$$\frac{0.7 \times \text{Btu input}}{111}$$

The figure 111 is intended to represent the capacity of each square inch of leader pipe, in Btu per hour, for first-story gravity flow connections. The air temperature rise is limited to 160 F above room temperature at high fire.

The draft is maintained between 0.02 and 0.06 in. water and the flue gas temperature, between 300 and 920 F, inclusive, above room temperature. The CO_2 in the flue gas is required to be at least 10 per cent and the smoke is limited to 10 per cent by the *ICHAM* test.

Solid-Fuel-Burning Forced-Air Furnaces

*Commercial Standard CS*109-44: Under this Commercial Standard, furnaces of the type covered are set up and tested with chestnut anthracite and without air filters. Each furnace is tested for maximum rating and for banking. The minimum rating is not established by test but is computed on the assumption of a fuel-burning rate 3 times that observed during the banking test and an efficiency equal to that observed during the maximum capacity test. A separate test is required to find whether or not any point on the air filter exceeds 90 F above room temperature when the furnace is operated at maximum capacity.

The maximum capacity is determined by the direct method; the air flow and temperature rise through the furnace being measured and the heat output computed from these observations. The test consists of one preliminary and three firing cycles. The end of a cycle is defined as that instant when the difference between the stack temperature and the room temperature drops to 75 per cent of the difference between the flue gas test temperature and room temperature. The flue gas test temperature is determined during the preliminary cy-

[1] Heating, Ventilating, Air Conditioning Guide, 1944, p. 360.

cle and is defined as the maximum temperature at which the furnace complies with the rating limits described below.

The efficiency is required to be 55 per cent or more when the draft is not more than 0.06 in. water and when the stack temperature does not exceed 830 F above laboratory temperature. The bonnet pressure is set at 0.2 in. water and the air temperature rise must be between 70 and 100 F. The firepot or other metal heat exchanger parts must not exceed 930 F above room, maximum, or 830 F above room on the average. The jacket temperature is limited to 230 F above room temperature except at points above the firing door and within 6 in. of the sides of the firing door frame and flue collar. During the banking test, the heat output is required to be not more than 25 per cent of that observed during the maximum output test, based on fuel consumption. The required banking periods are 12 hours for surface fired furnaces and 24 hours for magazine feed furnaces.

Oil Burning Floor Furnaces Equipped with Vaporizing Pot-Type Burners

*Commercial Standard CS*113-44: This standard applies to flue connected floor furnaces either with or without mechanical draft, forced circulation, or automatic controls.

Such furnaces are required to operate on high fire with an efficiency of not less than 70 per cent with a draft not exceeding 0.06 in. water, or less than 0.02 in. water and on low fire with a fuel rate not exceeding 25 per cent of that observed on high fire. Smoke is limited to 6 per cent by the *ICHAM* test, and the efficiency is determined by the indirect method.

The Commercial Standard contains also a table of factors for correlating fuel burning rates with altitudes above sea level.

Proposed Commercial Standard (Emergency) for Coal Burning Space Heaters

TS-3443: This proposed standard covers space heaters with capacities of 60,000 Btu per hour or less. Tests are made with chestnut anthracite and the required efficiency is 50 per cent or more for magazine heaters and 55 per cent or more for surface fired heaters. Flue gas temperature is limited to 900 F and the draft to 0.06 in. water and metal to temperatures below 1,000 F or below red heat and the jacket, if used, to 400 F or less except at points within 6 in. of the firing door, door frame, top grille or flue pipe. Attention periods of at least 6 hours for surface fired and of at least 12 hours for magazine heaters are required. Surface fired heaters must bank for at least 12 hours and magazine fed heaters for at least 24 hours with a combustion rate of not more than 25 per cent of that required for maximum rating. The minimum rating is computed with the assumption of a fuel burning rate three times that observed during the banking rate and an efficiency equal to that observed during the test at maximum rating.

Recommended Commercial Standard for Testing and Rating Hand Fired Hot Water Boilers

TS-3560*a*: This proposed standard covers solid-fuel-burning hot water boilers with capacities not exceeding 450 gal of water per hour with a temperature rise of 100 F.

Maximum output is defined as the average number of gallons of water which the device can heat through a temperature range of 100 F in one hour with continuous draw off of water, with the ashpit door closed and the ashpit damper open.

Minimum output is defined as the average number of gallons of water per hour heated 100 F with continuous draw off and with the fire banked, during a 12-hour period.

The tests are made with charcoal kindling and with anthracite chestnut or stove coal, as recommended by the manufacturer. Heaters with capacities less than 75 gal per hour are mounted on scales for test in order to facilitate measurement of the fuel burning rate.

At least two tests are required, each including a preliminary cycle and a test cycle. During a test, the discharged water temperature is regulated, by adjusting the flow, to 150 F $\pm$20 F. Correction for rating in gallons per hour at 100 F rise is then made by a formula based on direct proportion. Each test cycle begins when coal is shovelled on top of 3 to 6 in. of hot fuel (or 25 to 35 per cent of test fuel charge) remaining on the grate from the preliminary cycle. Adjustment of charge and/or draft is made so that test cycles run for 6 hours plus or minus 15 min. For boilers with capacities less than 75 gal per hour of capacity, the test cycles are considered to have ended when the charge of test fuel has been consumed. This is indicated by a loss of weight by the boiler and the fuel it contains equal to that of the test charge minus the ash it contains, estimated from an analysis of the fuel.

For boilers of 75 gal or more per hour of capacity, test cycles are considered ended when the thickness of the fuel bed, after shaking the grates, is equal to the thickness of the kindling bed from the preliminary cycle, plus or minus 25 per cent.

I-B-R Testing and Rating Code for Low Pressure Heating Boilers

These codes are available from the *Institute of Boiler and Radiator Manufacturers*, New York 17, N. Y. The testing and rating code covers heating boilers, of all sizes, both steam and hot water, hand, stoker and oil fired.

Ratings of hand-fired boilers are based on a drive test with an assumed chimney height. The draft, usually obtained by means of a fan or blower, is regulated to simulate the action of a chimney of the assumed height by means of curves given in the code. The test is made with anthracite. An efficiency of 58 per cent is required. The firing period, like the assumed chimney height, is different for boilers of different sizes and is indicated by curves contained in the code. Boilers with a gross output of less than one million Btu per hour are tested by condensing and weighing the steam. Large boilers may be tested by weighing the feed water.

Oil fired boilers are tested with No. 2 fuel oil with CO_2 in the stack gases set at 10$\pm$0.2 per cent and with a flue gas temperature not exceeding 600 F. An efficiency of 68 per cent is required. The rating for a boiler when stoker fired is assumed to be the same as that obtained for it by test with oil fuel.

The tests yield *Gross I-B-R outputs*. The gross I-B-R output is in each case converted into a net I-B-R rating by means of curves given in the code. The net I-B-R rating is less than the gross I-B-R output by a factor intended to account for the piping loss and pick-up.

Simplified Practice Recommendation R157-37

Steel heating boilers are usually rated by the formula contained in *Simplified Practice Recommendation R*157-37, entitled *Steel Horizontal Firebox Heating Boilers*. The rating of a hand-fired boiler in square feet EDR is defined as 14 times the heating surface in square feet, and that of a mechanically-fired boiler as 17 times the heating surface, in square feet. Compliance with ASME safety codes is required.

American Standard Approval Requirements for Central-Heating Gas Appliances

This code or list of requirements is approved by the *American Standards Association* and sponsored by the *American Gas Association*, New York 17, N. Y. It contains construction and performance requirements for gas burning boilers, warm air furnaces, and floor furnaces.

Codes are contained in the Requirements for testing these devices with natural gas (1135 Btu per cu ft), with manufactured gas (535 Btu per cu ft) with butane, or propane and with a butane-air mixture. Test pressures are specified for each of the test gases indicated. The efficiencies and capacities of devices tested are directly measured, and efficiency is based on the higher heating value of the fuel gas. Carbon monoxide in the

flue gases is required to be less than 0.04 per cent of an air free sample.

For steam boilers, the feed water is weighed and the weight used per hour is multiplied by the difference in enthalpy between the steam and feed water to determine the output. Hot water boilers are tested by the calorimetric method; the water flow rate is metered and its temperature rise is observed. The air flow rate for warm air furnaces, whether gravity or forced flow, and for floor furnaces is measured and its temperature rise is observed.

The efficiencies required for these appliances are as follows:

Appliances	Efficiency Required, Per Cent
Steam Boilers	75
Hot Water Boilers	75
Warm Air Furnaces	
Gravity	70
Forced	75
Floor Furnaces	
Gravity	65
Forced	70

Boilers may be either steel or cast-iron. Steam boilers are tested at atmospheric pressure and the steam quality is required to be at least 97 per cent. Each test is of 3 hours duration. Feed water is supplied from a tank, on a weighing scale, through an automatic water feeder. A complete heat balance is made but the rating is based on the steam produced. There is no allowance in the rating for piping and pick-up. The square foot EDR is defined as 240 Btu per hour. The flue gas temperature is limited to 480 F above room temperature.

Hot water boilers are tested with the discharged water at 180±2 F. Two tests are required, each of one hour duration. A complete heat balance is made but the rating and efficiency are based on the water flow rate and temperature rise There is no piping and pick-up allowance included in the rating. The square foot of hot water radiation is defined as 150 Btu per hour. The flue gas temperature is limited to 480 F above room temperature.

Gas burning forced air or fan type furnaces are tested with air filters, and other accessories included in the design, in place. For test, a furnace is equipped with one or more outlet ducts in which thermocouples are installed to measure the discharge air temperature. Restrictions are applied so that the furnace operates against a bonnet pressure of 0.2 in. water. A warm up period of one hour and two tests, each of at least one-half hour duration are required. The air temperature during the test is maintained between 70 and 100 F above room temperature and the air volume is measured by means of a meter in the inlet duct. Air filter face velocities are limited to 300 fpm or less. Fan furnaces are required to be equipped with automatic devices which will shut off the gas supply to the main burner at some outlet air temperature not in excess of 250 F and to turn on the gas when the air temperature drops to 135 F. The flue gas temperature is limited to 480 F above room temperature for either gravity or forced circulation furnaces. Heat exchanger metal temperatures are limited to 875 F and are required to reach temperatures of 178 F or more in from 15 to 20 min, from a cold start, depending on the inlet air temperature.

Gas burning gravity circulating furnaces are set up for test with warm air ducts with an aggregate area not exceeding that obtained by means of the following formula.

$$A = \frac{0.75\,q}{111}$$

A = total area of warm air ducts, square inches
0.75 = assumed efficiency
q = manufacturer's input rating, Btu per hour
111 = National Warm Air Heating Association's recommended heat carrying capacity for first-floor leaders, Btu per square inch

The openings are made to accommodate 10 in. pipe except that one opening may be smaller so that the required area can be approximately obtained. Sufficient pipe is attached to each opening to obtain an effective rise of 24 in. above the center of the opening. Outlet air temperatures are obtained by means of five thermocouples in each duct. Tests are of one-half hour duration, preceded by either a one hour warm-up period or 15 min between tests.

The furnace is operated first with gravity air flow and the observed air temperature rise is duplicated with an air metering device connected to the air inlet. The discharged air temperature is limited to 160 F above room temperature unless the furnace is equipped with an automatic device which will shut off the main burners when the outlet air reaches a temperature not in excess of 250 F.

Gravity flow gas floor furnaces are set up for test with a collar 2 in. high around the warm air discharge opening, with nine thermocouples arranged in equal areas inside the collar one inch above the grille. The floor furnace is then operated and the temperature rise and heat input are observed. The collar is then replaced by a stub duct, 28 in. high, containing thermocouples, one for each 16 sq in. of cross-sectional area, in a plane 24 in. above the grille. The 9 thermocouples, 1 in. from the grille, are replaced and an air metering device is connected to the cold air inlet. The operation previously observed is then duplicated and the efficiency and output are computed, based on the average air temperature 24 in. above the grille and on the rate of air flow indicated by the meter. Tests are of one hour duration, with an equal warming-up period preceding the first test and a 15 min warming-up period preceding subsequent tests.

Fan type gas floor furnaces are set up for test with a duct 28 in. high connected to the warm air outlet and air temperatures are measured with 16 or more thermocouples, none more than 6 in. from another, in a plane 24 in. above the grille. Air velocities in the test duct are determined by means of a velometer or pitot tube and temperatures in the duct are weighted for velocity. Ratings are based on air flow, determined with an air meter in the inlet duct, and the observed temperature rise. The air temperature is maintained between 70 and 100 F ±2 F above room temperature during tests. Filters and humidifiers, if used, are in place during tests. Filter air velocity is limited to 300 fpm or less.

Floor furnace outlet air temperature is limited to 350 F above room temperature, measured one inch above the grille as described previously. Fan furnaces without automatic shut-offs must meet this requirement with the fan stopped. Flue gas temperature for floor furnaces is limited to 530 F above room temperature.

None of the foregoing outlines is intended to contain all of the requirements and information to be found in the publication to which it relates. The purpose is to give those interested a broad view of how heating devices are tested and rated for heating capacity. Most of the publications discussed also contain requirements concerning construction, ease of operation and safety. Those contemplating test work should, of course, obtain copies of the code, requirements or standards applicable to the particular devices to be tested.

COWARD-EASTMAN CO. FORMED

The firm of Coward-Eastman Co., 2206 Chestnut St., Philadelphia 3, Pa., has been formed by Charles W. Coward and Carl B. Eastman. The firm will serve as sales engineers for mechanical equipment, particularly in the field of heating, ventilating and air conditioning in the Philadelphia area.

Mr. Coward was formerly President of the Coward Engineering Co., Camden, N. J., and Mr. Eastman was heating engineer for William A. Goff and formerly for many years was manager of C. A. Dunham Co. at Philadelphia.

Faneuil Hall, Boston, Mass.—Known as Cradle of American Liberty because of meetings held there prior to Revolution to protest obnoxious activities of English Government in Colonial matters. Presented to town of Boston in 1742 by Peter Faneuil for a market place and public town hall. Maintained by City of Boston. Since Revolution the Hall has been scene of patriotic meetings during Civil, Spanish and World Wars. Among famous names associated with Faneuil Hall are James Otis, Samuel Adams, Daniel Webster, President John Quincy Adams, Charles Sumner and Wendell Phillips. Custom House Tower in left background

Boston Ready for Annual Meeting

THE MEMBERS of Massachusetts Chapter await the opening of the 51st Annual Meeting, Hotel Statler, Boston, Mass., January 22, and anticipate with pleasure the arrival of Society members from the U. S. and Canada. Prior to the opening of the general sessions there will be a number of committee meetings on Sunday and Monday morning.

Registration will commence on Monday and the first session will be called to order by President S. H. Downs, Kalamazoo, Mich., at 2 p. m. on Monday afternoon. Three technical papers will be given and the Tellers of Election will make their report.

Technical sessions will be held all day Tuesday and Wednesday morning, and a variety of subjects has been selected by the Program Committee for discussion.

The papers will appeal to men of diversified interests, including those who design, install, or operate heating, ventilating, and air conditioning systems and equipment. The results of many research investigations will also be reported. In addition to the important business sessions, the Massachusetts Chapter Committee on Arrangements, through Earl G. Carrier, General Chairman, announces an interesting program of entertainment.

On Monday evening there will be a Get-Together Dinner and the menu will be an authentic New England Boiled Dinner with all the trimmings, followed by an entertainment program. Special events for the ladies will be a card party and tea and special trips to nearby historic shrines. Another trip of rare interest will be to the Ware Collection of Blaschka glass models of plants and flowers in the Botanical Museum of Harvard University. This collection of models was given to Harvard University by Mrs. Elizabeth C. Ware and her daughter, Miss Mary Lee Ware, as a memorial to Dr. Charles Eliot Ware. The University collection contains specimens illustrating 164 families of flowering plants.

On Wednesday morning there will be inspection trips to nearby plants for members and they are invited to register for these trips.

The concluding social event will be the annual dinner on Tuesday evening and the principal speaker will be Charles Winthrop Copp, who will speak on *Japan—Yesterday, Today, and Tomorrow.* For 21 years Mr. Copp lived in Japan as a teacher of English, and at the outbreak of the war he was imprisoned as a spy and was returned to the United States on the exchange ship Gripsholm. Mr. Copp is a graduate of Oberlin College and intimately knows the psychology of the people of Japan, their strength, their weakness, and their ideals. W. T. Jones, past president of the Society, will serve as toastmaster, and the presentation of the past president's emblem will be made. A typical New England seafood and lobster dinner will be served.

Reservation forms for the special events have been sent to all members and they are urged to assist the committee by making advance reservations.

Glass flower

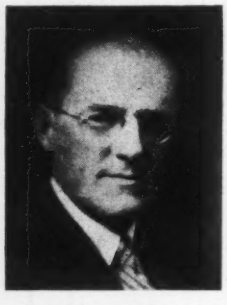
COMMITTEE ON ARRANGEMENTS

David Archer
Vice-Chairman

Earl G. Carrier
General Chairman

James Holt
Vice-Chairman

F. R. Ellis
Transportation



W. T. Jones
Advisory Chairman

G. B. Gerrish
Banquet

C. M. F. Peterson
Entertainment

Committee on Arrangements

Earl G. Carrier, *General Chairman*

Vice-Chairmen
James Holt and David Archer

W. T. Jones, *Advisory Chairman*

Banquet . . . . . **G. B. Gerrish**
Finance . . . . . **J. W. Brinton**
Transportation . . . . . **F. R. Ellis**
Publicity . . . . . **A. C. Bartlett**
Entertainment . . . . . **C. M. F. Peterson**
Ladies . . . . . **A. L. Hesselschwerdt, Jr.**
Reception and Registration . . . . . **P. A. Croney**

J. W. Brinton
Finance

P. A. Croney
Reception and Registration

A. C. Bartlett
Publicity

A. L. Hesselschwerdt, Jr.
Ladies' Entertainment

PROGRAM—51st ANNUAL MEETING

American Society of Heating and Ventilating Engineers

Boston, Mass. **January 22-24, 1945** **Hotel Statler**

Sunday, January 21

10:00 a.m. Committee Meetings
1:30 p.m. Council Meeting
2:00 p.m. TAC on Radiation and Comfort
4:30 p.m. Committee on Research
7:00 p.m. TAC on Heat Transfer of Finned Tubes

Monday, January 22

9:00 a.m. Registration
9:30 a.m. Chapter Delegates Conference
9:30 a.m. TAC on Glass
TAC on Fuels
TAC on Air Cleaning
TAC on Air Distribution and Air Friction
1:30 p.m. Joint Committee on Psychrometry
2:00 p.m. **Technical Session**—Pres. S. H. Downs, Presiding.
Reports of Officers and Council.
Studies of the Mechanism of Solution of CO_2 in Condensates Formed in the Steam Heating Systems of Buildings, by L. F. Collins.
Preventing the Solution of CO_2 in Condensates by Venting of the Vapor Space of Steam Heating Equipment, by D. S. McKinney, J. J. McGovern, C. W. Young and L. F. Collins.
Summer Weather Data and Sol-Air Temperature—Study of Data for New York City and Lincoln, Neb., by C. O. Mackey and E. B. Watson.
Reports of Tellers of Election.
2:00 p.m. Ladies' Card Party and Tea.
6:30 p.m. Get-together Supper—typical New England Dinner.
7:00 p.m. Organization Meeting, 1945 Committee on Research.

Tuesday, January 23

9:30 a.m. **Technical Session**—Vice-Pres. C-E. A. Winslow, Presiding.
Report of Committee on Research, by G. L. Tuve, Chairman.
Altitude Chamber for Study of Heating and Air Conditioning Problems, by W. E. Crowell.
Thermodynamic Properties of Moist Air, by John A. Goff.
Air Cooling Coil Problems and Their Solutions, by L. G. Seigel.
12:30 p.m. Nominating Committee Meeting.
1:30 p.m. Visit to Botanical Museum of Harvard University, Ware Collection of Blaschka Glass Flowers.
2:00 p.m. **Technical Session**—Vice-Pres. A. J. Offner, Presiding.
Report of Guide Committee, by J. F. Collins, Chairman.
A Survey of Testing Methods and Rating Limits for Domestic Heating Devices, by R. S. Dill.
The Influence of Heat Capacity of Walls in Interior Thermal Conditions and Heat Economy, by C-E. A. Winslow, L. P. Herrington and R. J. Lorenzi.
Radiation Corrections for Basic Constants Used in the Design of All Types of Heating Systems, by B. F. Raber and F. W. Hutchinson.
7:00 p.m. Annual Banquet—*Toastmaster*, W. T. Jones. *Address:* Japan—Yesterday, Today, and Tomorrow, by Charles Winthrop Copp.

Wednesday, January 24

9:30 a.m. **Technical Session**—Pres. S. H. Downs, Presiding.
Control of Industrial Atmospheres, by W. N. Witheridge.
Mine Ventilation and Its Relation to Health and Safety, by D. Harrington.
Tobacco Smoke Control—A Preliminary Study, by C. S. Leopold.
Noise Rating of Ventilating Fans, by W. H. Hoppmann and Fred Lager.
Unfinished Business (Reports of Committees).
Installation of Officers.
New Business—Resolutions.
Adjournment.
1:30 p.m. Inspection Trips.
1:30 p.m. Organization Meeting of Council.

Method of Choosing Location of, Financing and Conducting Meetings of the Society

Resolved: That inasmuch as the Annual and Semi-Annual Meetings of the Society come under the jurisdiction of the Council, the following rules governing the handling of such meetings be adopted by the Council and published in the Journal of the Society at least twice during every year, preferably just prior to each meeting.

1—The Council will select the city in which the Annual or Semi-Annual Meeting is to be held, giving due consideration to the invitations received from Chapters or members as well as to the advisability of so distributing those meetings as to make them of the greatest advantage to the general membership, and to reduce as far as possible the expense of members attending.

2—That an appropriation be made to cover the entertainment or local expenses, incurred in connection with the meeting not exceeding $500.00, the regular meeting expense to be taken care of by the General Fund of the Society in the regular way.

3—That no registration fee or compulsory obligations of any nature be imposed on members or guests.

4—That the purchase of tickets for banquets or for any other form of entertainment that may be provided be entirely voluntary.

5—That the grouping of features and the sale of tickets for group features be discouraged.

6—That the raising of funds from manufacturers of heating apparatus be discouraged.

7—That the display of samples, or of literature, advertising the product of any manufacturer in any way, shape or form, be not permitted at the booths, registration desk, or in or about the meetings.

8—That the distribution of trade papers be entirely at the discretion of the committee in charge.

9—That the local Chapter or local members be empowered to form a General Committee with such sub-committees as may be required to handle the details of transportation, hotel accommodations, entertainment, finance, etc., and that this General Committee be requested to confer frequently with the Council, through the Secretary of the Society, and to make frequent reports on progress in connection with the various matters being handled by them.

10—That the arrangements of elaborate and costly entertainment features be discouraged.

Adopted at Council Meeting, January 29, 1926.

CHAPTER SPEAKERS

The Chapter Relations Committee is supplying speakers to Chapters for 1945 program, and according to the announcement of H. E. Sproull, Chairman, arrangements have been confirmed for visits by Prof. F. W. Hutchinson of the University of California—Utah, January 15; Denver, January 17; Omaha, January 18, and Indianapolis, January 26.

Brigadier General W. A. Danielson, member of the Council, will visit the Kansas City Chapter on February 5; Iowa Chapter, February 7, and Nebraska Chapter, February 8.

F. C. McIntosh of Pittsburgh is to visit St. Louis Chapter February 6.

Prof. B. H. Jennings of Northwestern University will address the Pittsburgh Chapter February 12.

Cyril Tasker, Director of ASHVE Research, will be at the Michigan Chapter meeting March 12.

R. E. Moore of Chicago will speak to the Cincinnati and Central Ohio Chapters.

CARL BAUMGARDNER NOW GENERAL MANAGER OF SALES

C. M. Baumgardner, manager of Chicago Branch of United States Radiator Corp., has been appointed general manager of sales, with headquarters in the general offices, Detroit, Mich., according to a recent announcement.

Mr. Baumgardner has been associated with the corporation for many years and for the past 15 years has been manager of the Chicago Branch with jurisdiction over sections of Michigan, Indiana, Illinois and Iowa.

He is succeeded in Chicago by S. Wolpert, formerly assistant branch manager, and A. X. Bergeron has assumed the duties of assistant branch manager.

Mr. Baumgardner joined the ASHVE in 1928 when he was located in St. Louis. He attended the University of Michigan and has specialized in heating and power fields.

CONSOLIDATED EXPANDS

With a view to increased postwar selling activity, the Consolidated Conditioning Corp., Mount Vernon, N. Y., has expanded its organization.

Russell Tree, Northeastern District manager of the Carrier Corp., has resigned his position to become president of the Consolidated Conditioning Corp. Ray Duncan and Lewis Wachs, sales engineers for the Carrier Corp., have also left that company to join the Consolidated sales staff.

FOREIGN DISTRIBUTION REPRESENTATIVE APPOINTED BY VIKING

Marion I. Levy, president of Viking Co., 5600 Walworth Ave., Cleveland, Ohio, announces the appointment of its first foreign distribution representative. At a recent meeting Mr. Levy also announced that Polak, Winters Co., San Francisco, Calif., will represent Viking products in South and Central America. Until now distribution of its blowers, humidifiers, attic and industrial fans, has been confined to the United States and Canada, but the new plan is to enter the world market when the industry gets the *go-ahead* signal.

At the moment, as in thousands of other American industrial plants, Viking is doing its part in war production and has temporarily laid aside its civilian production.

LT. DOSTER FEARLESS PIONEER

The first man ever picked up from the ground by an airplane in full flight was Lieut. Alex Doster, Jr. (son of Alex Doster, Vice-President and Secretary of Torrington Mfg. Co., Torrington, Conn.), who was posthumously awarded the Distinguished Flying Cross, the highest decoration which can be made by the Army Air Forces. The dramatic story of this experiment in September 1943 is given by Paul Gallico in the December 23, 1944, issue of the *Saturday Evening Post*.

Alex Doster, Jr., was a paratrooper who volunteered to be a human guinea pig in the experiment, which will save the lives of many American boys who are stranded in otherwise inaccessible places, in the jungle, desert, or ice caps of the North. The late Lieutenant Doster was the victim of "polio" contracted in Egypt many months later, although he had survived one of the most dan[gerou]s experiments made by a [huma]n being.

He was a Charter Memb[er] and held the No. 1 card of the m[ost] exclusive club in the world, w[hich] to date has only four known m[embers] —the *Guinea Pigs* who hav[e] participated in the human pick-up.

Those who knew Lieutenant Dos[ter] ter recall him as the ideal t[ype] of American boy, a six footer, [Kaba] and genial. He attended Ya[le], en[listed] and won his commission [in] the paratroopers. His early death was an ironic tragedy to his wife and family, but the revelation of his great accomplishment which will mean so much to the Service remains as a fitting monument to one of the bravest men in the American Army.

DEATHS OF MEMBERS RECENTLY REPORTED

The headquarters office of the Society has just received word of the deaths of the following members:

JOHNSTON, Marriott T., passed away in March 1944. He was born in Baltimore, Md., February 4, 1901, graduated from the Baltimore Polytechnic Institute, and received his B.S. in mechanical engineering from Johns Hopkins University. Mr. Johnston spent 10 years actively engaged in the design, supervision of installation and operation of air conditioning, ventilation, heating, and refrigeration systems for Walgreen Co., Chicago.

In 1939 he became engineer for the Bankers Life Co., Des Moines, Ia. He joined the ASHVE in 1939.

SCHULZ, Howard I., Richmond, Va., died in July 1944, having held membership in the Society for over 29 years. He was born on January 21, 1885, in Baltimore, Md., where he attended public school and the Baltimore Polytechnic Institute. He received his drafting experience with Crook-Horner Co., Baltimore, and in 1905 entered the employ of Crane Co. as steam specialty expert. He later became assistant manager of the Baltimore branch. In 1930 he became manager of the Crane Company's office at Richmond, Va., which position he held at the time of his death.

SHERWOOD, Laurence T., Dunbar, Pa., a member of the Research Technical Advisory Committtee on Glass, passed away, July 26, 1944. Mr. Sherwood was born at Wilton, Ia., on August 15, 1886. He prepared at the Waynesville, Ohio, High School, and received his A.B. and A.M. from Swarthmore, majoring in chemistry. In 1917 he joined the staff of E. I. du Pont de Nemours Co., Wilmington, Dela., as supervisor of manufacturing

department, remaining with them until 1925. He then became glass technologist for the Pennsylvania Wire Glass Co., Dunbar, Pa., which he held until his death. He joined the Society in 1937 and took an active part in the affairs of the Pittsburgh Chapter, and served on several of the Research Technical Advisory Committees.

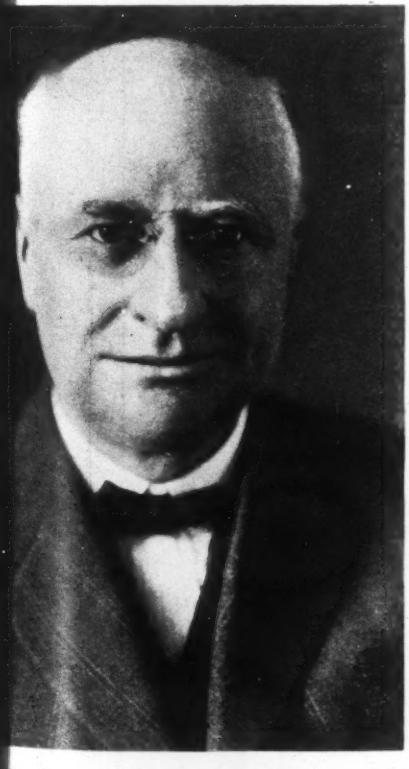
RAVEN, Andrew H., Sioux City, Ia., died of a heart attack on October 16, 1944, while on his way to the Wigman Co., where he was employed as heating engineer and salesman for the past 21 years. Mr. Raven was born at Oyens, Ia., on April 9, 1881, where he attended the local schools. He later attended Trinity College, Blair, Nebr. He had been a member of the Society since 1937.

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their sincere and heartfelt sympathy to the members of the families of these deceased members of the Society.

JOHN D. CASSELL, LIFE MEMBER

The many friends of John D. Cassell, Life Member and former member of the Council of the Society, will regret to learn that he died in his sleep at his home, October 5, 1944.

He was born on January 1, 1860 in Marietta, Pa., and from 1874-78 he served his apprenticeship with Dietrich Bros., Philadelphia.



John D. Cassell

He received his shop training from 1880-1890 with Thompson Bros., Philadelphia and then became a draftsman with the Philadelphia Board of Education. He later became superintendent of heating plants and was responsible for the design and operation of hundreds of heating and ventilating systems in the city school buildings.

Mr. Cassell joined the Society in 1913 and served on many committees of the Society, and as the first President of Philadelphia Chapter in 1916.

Mr. Cassell served on the Committee on Schoolhouse Standards, Committee on Increase of Membership, Nominating Committee, F. Paul Anderson Committee, Executive Committee, and he was one of the ardent supporters of the Society's research work.

In 1927, after 36 years of continuous service with the Board of Education, Mr. Cassell was presented with a medal by the Philadelphia Society of Municipal Engineers by Mayor Kendrick of Philadelphia. Mr. Cassell retired from active work on August 31, 1930.

After his retirement from business, Mr. Cassell continued his interest in the Society and was a well-known figure at Society meetings for many years. He became a Life Member of the Society in 1931.

Mr. Cassell is survived by two daughters to whom the Officers and Council of the Society extend their sincere sympathy.

LT. ROSAS KILLED IN ACTION

Word has been received that First Lieutenant Milton L. Rosas, pilot of a Liberator bomber, was killed in action in Germany, June 20, 1944. He was on his 23rd mission over Politz.

In previous action he had been wounded on March 15 and had received the Purple Heart, as well as the Air Medal with three Oak Leaf Clusters.

Prior to his entrance into the Army, Lieutenant Rosas had been in estimating and sales work with Roy E. Gorgen Co., Minneapolis, Minn.

Lieutenant Rosas was born September 16, 1919, in St. Paul, and

Lt. Milton L. Rosas

received his education in local schools before entering the University of Minnesota. He was graduated from Dunwoody Institute in 1941, specializing in heating, ventilating and air conditioning. He became a Junior Member of the Society in 1941 and shortly thereafter he entered the service in which he made a distinguished record.

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their sincerest sympathy to his mother, Mrs. L. Rosas, 139 E. Congress St., St. Paul, who survives.

J. I. KRUEGER, LIFE MEMBER, DIES ON THE COAST

Word has just reached us of the passing of James I. Krueger at the age of 75, Life Member of the Society, after a long illness.

Mr. Krueger was a well-known manufacturers' representative on the Pacific Coast, and for 30 years specialized in the steam heating and power plant equipment fields. He was born on April 24, 1869, at Butte, Mont., and after his early schooling he worked as an apprentice steamfitter, and in 1889 opened a steam heating and ventilating establishment, which he continued until 1912.

Before his illness he regularly attended Society meetings and was greatly interested in the establishment of the Golden Gate Chapter. Since his retirement from active business he made his home with his son, Capt. Albert P. Krueger (MC), USNR, in Berkeley.

Mr. Krueger had a host of friends who will miss him, and the Officers and Council of the Society extend their sincere and heartfelt sympathy to his family for the great loss they have sustained.

SUMMARY OF LOCAL CHAPTER MEETINGS

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Atlanta	Nov. 20	Progress and Future of the Freezer Locker Plant in Georgia	W. A. Tadlock, Georgia Tadlock Co., Atlanta	"Revolution in the Pantry" (film), shown by Mr. Lehman, Armstrong Cork Co.	16	0.32
Central Ohio	Nov. 20	Radiant Heating	C. A. Hawk, Jr., A. M. Byers Co., Pittsburgh, Pa.	Round Table discussion	46	0.61
Connecticut	Nov. 8	Industrial Applications of Westinghouse Precipitron Equipment	C. E. Howell, Boston, Mass.	Sound Movie on Make-up of Electronics Equipment — Present and Future Possibilities of Electronics	55	1.7
Delta	Nov. 17	Radiant Heating	C. A. Hawk, Jr., A. M. Byers Co.	Delta members were guests of New Orleans *ASME* Chapter	39	0.50
Golden Gate	Nov. 6	Electronics	John Haines, Minneapolis - Honeywell Regulator Co.	Three colored films released by U. S. Army: Basic Electricity, Basic Electronics, and C-1 Auto Pilot	59	0.35
Illinois	Nov. 13	Methods of Heating and Ventilating Modern Hospitals	Everett W. Jones, Vice - Pres., Modern Hospital Publishing Co., Chicago	Discussion. S. R. Lewis described the use of panel heating at the Children's Hospital in Denver Committee reports were given by Messrs. Ericsson, Kearney and Prentice	74	0.47
Indiana	Nov. 24	Altitude Testing Aircraft Engines in the Laboratory	C. L. Bouchard, Chief Engr., Allison Motors Div. of General Motors		56	0.78
Iowa	Nov. 14	Resumé of Work and Travels Since Pearl Harbor	E. H. Borg, Proudfoot, Rawson-Brooks & Borg, Des Moines, Ia.	Discussion on central systems for school ventilation vs. unit ventilators	16	0.67
Manitoba	Nov. 2	Summary of Research	D. S. Swain, Sales Engr., Trane Co. of Canada, Ltd., Winnipeg		16	0.56
Memphis	Oct. 18	Chapter Installation Charter Presented	Pres. S. H. Downs, Kalamazoo, Mich.	W. A. Russell, Kansas City, Mo., reviewed recent chapter installation at Denver	27	
		Past, Present and Future	M. F. Blankin, Past-President ASHVE, Philadelphia	Temporary officers elected as permanent officers		
		Value of Chapter Meetings and Benefits Derived Therefrom	Brig. - Gen. W. A. Danielson, Memphis, Tenn.	Dr. Weiss, Pres. of Memphis Engineers' Club, was introduced		
Minnesota	Nov. 6	Typical Dust Control Installation (illustrated with slides)	John M. Kane, Dust Control Div., American Air Filter Co., Inc., Louisville, Ky.	Lyman Gross, Chairman of Membership Committee, gave his report E. F. Bell and J. E. Haines were unanimously elected as Representative and Alternate on Nominating Committee	39	0.42
Montreal	Nov. 20	Acoustics	Prof. Reilley	R. F. Wormley and F. A. Hamlet were named as Delegate and Alternate to 51st Annual Meeting in Boston	31	0.65

CHAPTER	MEETING DATE	SUBJECT	SPEAKERS	OTHER FEATURES	ATTENDANCE	ATTENDANCE RATIO*
Nebraska	Nov. 8	Condensation in Buildings	Prof. F. B. Rowley, Dir., Engrg. Experimental Station, University of Minnesota	Illustrated talk with slides showing construction of walls	36	2.6
New York	Nov. 20	Heating and Air Conditioning Design and Construction Practices in Latin America	Alfred J. Offner, 2nd Vice-Pres. of ASHVE, New York, N. Y.	C. S. Koehler and H. J. Ryan were selected as Representative and Delegate as well as on Nominating Committee	70	0.38
		Society Research	W. L. Fleisher, Past Pres. of ASHVE, New York, N. Y.			
North Texas	Nov. 13	Radiant Heating for Post-War	C. A. Hawk, Jr., A. M. Byers Co., Pittsburgh, Pa.	Nominees for 1945 announced by Pres. L. C. McClanahan	48	0.96
Northern Ohio	Nov. 13	Forced Hot Air Panel Heating	H. F. Randolph, Vice-Pres., International Heater Co., Utica, N. Y.	John James and D. L. Taze were named representative and Alternate on Nominating Committee; R. H. Cutting and Paul Gayman were elected	111	0.57
		Gravity Type Hot Air Panel Heating	R. R. Houser, Bryant Air Conditioning Corp., Detroit, Mich.			
		Globe Thermometers	Cyril Tasker, Dir. of Research, ASHVE			
Ontario	Nov. 6	Radiant Heating	C. A. Hawk, Jr., A. M. Byers Co., Pittsburgh, Pa.		154	0.44
Oregon	Nov. 9	Electronics as Applied to Control of Heating and Air Conditioning	John E. Haines, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.	Pres. E. C. Willey spoke on research activities	50	1.0
	Oct. 5	National Fuel Efficiency Program	G. H. Risley, Mgr., Cole Draft Governor Co., Portland, Ore.	Reports on Standing Committees were presented	16	0.32
		Resumé of Research Work on Loss of Heat Through Wet Walls	Prof. E. C. Willey, Oregon State College	E. O. Williams, Pacific Telephone Co., exhibited sound films on radio or booster tubes		
Pacific Northwest	Nov. 14	Flight Control Used on Military Planes (3 training films used by U. S. Army)	Presented by John E. Haines, Minneapolis-Honeywell Regulator Co.	D. C. Griffin and E. H. Langdon were appointed Delegate and Alternate to 51st Annual Meeting, January 1945	46	0.55
		Future of Electronics	Mr. Haines			
Philadelphia	Nov. 9	The Air-Cooled Human Body	Dr. C.-E. A. Winslow, 1st Vice-Pres. of ASHVE, New Haven, Conn.	Resolution on death of John D. Cassell, 1st Pres. of Chapter, was presented	44	0.37
Pittsburgh	Nov. 13	Heating and Air Conditioning in Latin American Countries	Alfred J. Offner, 2nd Vice-Pres. of ASHVE, New York, N. Y.	T. F. Rockwell spoke for Executive Committee on construction program	30	0.49
St. Louis	Nov. 9	Research and Industry	Cyril Tasker, Dir. of Research, ASHVE, Cleveland, Ohio	Open discussion followed	30	0.51
South Texas	Oct. 22	Gas Burners, Safety Controls, Flues, Flue Breechings	L. S. Regan, Vice-Pres. Webster Burner Co.	Pres. Barnes discussed chapter By-Laws	26	1.13

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Southern California	Nov. 8	Resumé of History of State Registration of Civil Engineers	Paul E. Jeffers, Industrial Engr.	Maron Kennedy and Art. Theobald were selected as Delegate and Alternate to 51st Annual Meeting in Boston in January	52	0.7
		Constituents in Natural Gas Served in California	Art. Theobald, Chief Engr., Payne Furnace and Supply Co., Los Angeles			
Washington, D. C.	Nov. 8	Marine Ventilation	Victor J. Cucci, Consulting Engr., New York, N. Y.	S. L. Gregg reported on Chapter Sponsored Research	71	0.4
Western New York	Nov. 17	Joint Meeting with Air Conditioning Council			49	0.8
Wisconsin	Nov. 20	Trouble Shooting	S. R. Lewis, Consulting Engr., Chicago, Past Pres. of ASHVE	Interesting Discussion on panel heating followed	72	1.2

*The attendance ratios shown represent the meeting attendance divided by the Chapter membership. These will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by other local chapters and may be helpful in deciding on subjects for other chapter meetings.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 65 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by January 20, 1945, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
Albert, William J., Chief Draftsman, George C. Lewis, Philadelphia, Pa.	W. J. Searle, Jr. G. F. Bertrand	Morris Sheffler G. C. Lewis
Artran, Carlyle, Engr., General Air Conditioning Corp., Los Angeles, Calif.	F. L. McDonald W. O. Stewart	Leo Hungerford R. A. Lowe
Baker, Henry A., Vice-Pres., W. B. Connor Engineering Corp., New York, N. Y.	A. C. Buensod H. T. Porter	H. J. Ryan, Jr. F. H. Munkelt
Bemarkt, George H., Mgr., Heating Dept., N. O. Nelson Co., St. Louis, Mo.	E. E. Carlson J. S. Malone	B. L. Evans J. J. Blackmore
Bilderback, George R., Comm'l Supvsr., Advanced Refrigeration, Inc., Atlanta, Ga.	R. F. Hahn C. L. Templin	L. C. Boland, Jr. L. L. Barnes
Bleier, Frank P., Dir. of Research, Ilg Electric Ventilating Co., Chicago, Ill. *(Advancement)*	J. M. Frank A. G. Sutcliffe	B. L. Casey U. R. Furst
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Carley, Thomas S., Sales Engr., Minneapolis-Honeywell Regulator Co., San Francisco, Calif.	H. V. Hickman C. L. Peterson	K. O. Alexander N. H. Peterson
Champlin, Robert C., Air Cond. Engr., Timken Detroit Axle Co., Detroit, Mich.	F. R. Bishop E. B. Root	W. G. Boales G. H. Tuttle
Chur, Charles H., Jr., Mgr., W. A. Case & Son Manufacturing Co., Syracuse, N. Y.	J. W. Stevens D. D. Wile	C. F. Woese C. M. Ashley
Corlew, James B., Design Draftsman, Newport News Shipbuilding & Drydock Co., Newport News, Va.	*Chester Ashby *H. A. Ross-Clums	*C. B. Coe *R. V. Terry

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GABBERT, WILLIAM L., Dist. Sales Mgr., American Air Filter Co., Inc., Louisville, Ky.	Arthur Nutting J. W. May	H. W. Pound H. C. Murphy
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HENRY, RAY W., Salesman, W. B. Young Supply Co., Kansas City, Mo.	R. B. Mason W. A. Russell	F. C. Burns M. M. Rivard
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HOLDBROOK, JOHN A., Research Engr., Century Engineering Corp., Cedar Rapids, Iowa.	C. P. North E. O. Olson	W. W. Stuart T. R. Johnson
HOLTON, WILLIAM J., Reeves Wiedeman Supply Co., Kansas City, Mo.	R. B. Mason W. E. Howarth	F. C. Burns M. M. Rivard
HOROWITZ, HARRY, Sales Engr., Albany, N. Y.	G. A. Teeling K. L. Mytinger	H. A. Bond R. C. Taggart
JOHNSON, HIRAM K., Mgr., Heating Dept., Brown Steel Tank Co., Minneapolis, Minn.	L. G. Gross C. P. Petersen	William McNamara J. F. Stafford
JUHL, EDWARD F., Chief Engr., Thorpe Bros., Inc., Minneapolis, Minn.	L. G. Gross R. E. Gorgen	William McNamara H. E. Gerrish
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LITTLE, HERBERT J., Student, University of Western Australia, Nedlands, Western Australia.	*O. F. Blakey *P. H. Fraenkel	*R. St. C. Pitt *M. V. Perry
LUSK, HARRY E., Mgr., DeWitt C. Griffin & Associates, Seattle, Wash.	D. C. Griffin R. E. Le Riche	E. H. Langdon K. H. Norby
MCGRUER, ALFRED E., Canadian Pacific Railway Co., Toronto, Ont., Canada.	E. W. Twizell L. A. Hood	R. Grossman J. A. Shaw
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PASIADIS, FEDON H., Graduate Student, University of Michigan, Ann Arbor, Mich.	Axel Marin *H. E. Keeler	*R. S. Hawley *F. Schwartz
PHELAN, JAMES H., Engr. and Estimator, G. W. Cunningham Co., Columbia, Conn.	P. D. Bemis C. W. Kimball	W. J. Ahearn H. B. Wiegner
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RITCHIE, GEORGE W., General Motors Bomber Plant, Cleveland, Ohio.	S. F. Schultz L. E. Slawson	J. F. Platz W. A. Evans
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SHESLER, JOHN A., Field Engr., Hoffman Specialty Co., Inc., Yonkers, N. Y.	E. N. Sanbern C. W. Stewart	Ferdinand Jehl Martin Christe
SIMPSON, HARRY, Htg. Contractor, Toronto, Ont., Canada.	J. A. Clifton H. R. Roth	W. H. Evans V. J. Jenkinson
TAYLOR, ERIC L., Director and Tech. Adviser, The Premier Heating & Ventilating Co., Ltd., Leicester, England.	*James Stinton-Jones *Frank Goodchild	*S. M. James *D. J. Ritchley
TAYLOR, EDMUND P., Supt., Plumbing & Heating, Buckingham-Routh Co., Wallingford, Conn.	J. R. Smak T. J. Converse	Winfield Roede P. D. Bemis
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TRACY, JOHN W., Sales Engr., Minneapolis-Honeywell Regulator Co., Pittsburgh, Pa.	L. S. Maehling O. L. Williams	H. J. Kirkenda E. H. Riesmeye Jr.
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WESLEY, WILLIAM, Owner, Wesley Refrigeration Service, Rome, N. Y.	J. W. Stevens C. M. Ashley	W. L. Lynch D. D. Wile
WIIK, EDWARD M., Major, U. S. Army, Ordnance Dept., c/o Postmaster, San Francisco, Calif.	H. M. Betts H. O. Mills	Lyman Gross C. E. Wiser
WILLIAMS, GEORGE R., Gen. Mgr., Stoherette Manufacturing Co., Chicago, Ill.	K. C. Richmond E. M. May	*E. E. Kennedy *A. M. Hull

*Non-Member.

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

ARNOLD, RICHARD S., Asst. Chief Engr., Carrier Corp., Atlanta, Ga.

ASHLEY, RONALD D., Partner, United Equipment Co., Columbus, Ohio.

BERNSTROM, C. BERTIL, Development Engr., D. J. Murray Manufacturing Co., Wausau, Wis. *(Reinstatement)*

COLE, HAROLD S., Engr., Stone & Webster Engineering Corp., Boston, Mass.

FERRIS, DONALD M., Mech. Engr., Budd Wheel Co., Detroit, Mich. *(Reinstatement)*

GAY, CLARENCE E., SR., Mgr., Heaven Engineering Co., Kansas City, Mo.

HOYT, W. B., The Hoyt-Grant Co., New Haven, Conn. *(Reinstatement)*

JACKSON, ROBERT B., Partner, Lieb-Jackson Co., Columbus, Ohio.

MCLENNAN, MILLARD C., Puget Sound Navy Yard, Seattle, Wash.

MICHAEL, LEONARD A., Dist. Mgr., C. A. Dunham Co., Denver, Colo. *(Reinstatement)*

NEWTON, DAVID A., Chief Engr., Larkin Coils, Inc., Atlanta, Ga.

ORMSBY, H. KINGSLEY, JR., Owner, Syracuse General Sales Co., Syracuse, N. Y. *(Reinstatement)*

RICHMOND, JOHN, Engr. and Estimator, The Sweeney & Wise Co., Cleveland, Ohio.

ROBINSON, MAYES R., Engr., Robinson Ventilating Co., Zelienople, Pa. *(Reinstatement)*

STEARNS, ELLIS, JR., Engr., National Bureau of Standards, Washington, D. C.

WALKER, KIRBY, Hagerstown, Md. *(Reinstatement)*

WOLFE, CHARLES H., Mech. Engr., Columbus, Ohio.

WOLLERMAN, ARTHUR E., Sales Mgr., B. F. Sturtevant Co., Columbus, Ohio.

ASSOCIATES

ALLEN, HAROLD D., Mech. Engr., N.A.C.A., Cleveland Airport, Cleveland, Ohio.

BARTON, LAWRENCE R., Asst. Chief Engr., Hayes Bros., Inc., Indianapolis, Ind.

BELL, THOMAS H., Engr. and Supt. of Construction, Columbus Heating & Ventilating Co., Columbus, Ohio.

BROWN, ROBERT M., Owner, Brown & Co., Atlanta, Ga.

EWALD, JOHN H., Vice-Pres., James E. Degan Co., Detroit, Mich.

HORNER, FRANK S., Jr. Construction and Maint. Engr., Burroughs Adding Machine Co., Detroit, Mich.

JAMISON, ERNEST K., Field Project Mgr., The Huffman-Wolfe Co., Atlanta, Ga.

KEIST, WALTER E., Partner, W. J. Keist & Son, Pittsburgh, Pa. *(Reinstatement)*

LITTLE, VERNON R., Chief Steam Engr., Curtiss-Wright Corp., Columbus, Ohio.

LOFTE, JOHN A., Engr., Trane Company, Milwaukee, Wis. *(Reinstatement)*

RODWELL, ROBERT D., Mech. Engr., Columbus Heating & Ventilating Co., Columbus, Ohio.

ROTHROCK, RALPH K., Sales Engr., New Orleans, La.

SCHUMACHER, JOHN F., Draftsman, Columbus Heating & Ventilating Co., Columbus, Ohio.

SEABRIGHT, FREDERICK C., Engr., Columbus Heating & Ventilating Co., Columbus, Ohio.

SPITZLEY, RAY L., General Petroleum Corp., Vernon, Calif.

STOBBE, GUSTAV C., Gen. Supt., Becker-Seidel-Clark Co., Cleveland, Ohio.

STONER, WILLIAM C., Dist. Repr., Chrysler-Airtemp, Atlanta, Ga.

VALIQUET, H. H., Vent. Engr., Employers Mutual Liability Insurance Co., Milwaukee, Wis. *(Reinstatement)*

VITALI, ORESTE J., Htg. Contr., United Engineering Co., North Bergen, N. J.

WALLACE, JAMES B., Mfrs'. Repr., Taco Heaters, Inc., and Lau Blower Co., Dearborn, Mich. *(Reinstatement)*

WEST, JOSEPH H., Owner, West Brothers Sheet Metal, Atlanta, Ga.

WISE, RAY A., Member of Firm, The Sweeny & Wise Co., Cleveland, Ohio.

ZAHNER, LEO W., SR., Owner, A. Zahner & Co., Kansas City, Mo.

ZELLAK, JOSEPH, Engr. and Estimator, Sauer Co., Inc., Columbus, Ohio.

JUNIORS

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MORSE, ELWIN F., Field Engr., B. F. Sturtevant Co., Cleveland, Ohio.

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First Vice-President ..... C.-E. A. WINSLOW
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Two Years: J. F. COLLINS, JR., JAMES HOLT, E. N. MCDONNELL, T. H. URDAHL.

One Year: W. A. DANIELSON, L. G. MILLER, A. E. STACEY, JR., B. M. WOODS, M. F. BLANKIN, G. L. TUVE, *Ex-Officio.*

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Finance—B. M. Woods, *Chairman;* L. E. Seeley, T. H. Urdahl, L. P. Saunders, *Ex-Officio.*

Membership—M. F. Blankin, *Chairman;* J. F. Collins, Jr., G. D. Winans.

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Standards—L. P. Saunders, *Chairman;* C. M. Ashley, James Holt.

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Nominating Committee

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Delta	J. S. Burke	C. B. Gamble
Golden Gate	R. A. Folsom	C. E. Bentley
Illinois	E. M. Mittendorff	A. O. May
Indiana	G. B. Supple	J. G. Hayes
Iowa	C. W. Helstrom	W. W. Stuart
Kansas City	D. M. Allen	W. A. Russell
Manitoba	F. L. Chester	William Glass
Massachusetts	E. G. Carrier	R. T. Kern
Michigan	S. S. Sanford	W. H. Old
Minnesota	R. C. Jordan	F. B. Rowley
Montreal	T. H. Worthington	A. B. Madden
Nebraska	D. E. McCulley	B. G. Peterson
New York	R. A. Wasson	C. S. Koehler
North Carolina	Arvin Page	P. L. Guest, Jr.
North Texas	G. A. Linskie	E. T. Gessell
Northern Ohio	L. S. Ries	John James
Oklahoma	E. T. P. Ellingson	
Ontario	V. J. Jenkinson	W. C. Kelly
Oregon	E. C. Willey	
Pacific Northwest	M. N. Musgrave	J. D. Sparks
Philadelphia	H. B. Hedges	Edwin Elliot
Pittsburgh	T. F. Rockwell	E. H. Riesmeyer, Jr.
St. Louis	G. B. Rodenheiser	C. F. Boester
South Texas	J. A. Walsh	A. B. Banowsky
Southern California	Leo Hungerford	W. O. Stewart
Washington, D. C.	F. A. Leser	W. H. Littleford
Western Michigan	C. H. Pesterfield	J. W. Miller
Western New York	S. M. Quackenbush	S. W. Strouse
Wisconsin	A. S. Krenz	M. W. Bishop

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, M. M. Crout, 412 Houston St., N. E. Secretary, L. L. Barnes, 3995 N. Stratford Rd.

Central New York: Organized, 1944. Headquarters, Syracuse, N. Y. President, Milner Noble, 410 S. Geddes St. Secretary, F. E. Hockensmith, 400 N. Midler Ave.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. President, J. D. Slemmons, 2 Fifteenth Ave., Columbus 1. Secretary, A. W. Williams, 5 E. Long St., Room 808, Columbus 15.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, O. Meets, Second Tuesday. Honorary President, Capt. C. E. Hust. President, G. V. Sutfin, 1005-6 American Bldg., Cincinnati 2. Secretary, A. W. Edwards, 626 Broadway, Rm. 307, Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, L. A. Teasdale, 20 Ashmun St. Secretary, Winfield Roeder, 405 Temple St.

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, L. V. Cressy, 423 Baronne St., New Orleans 13. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9.

Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, C. L. Peterson, 2 Indian Rock Path, Berkeley. Secretary, James Gayner, 260 California St., San Francisco 11.

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, A. O. May, Room 925, 53 W. Jackson Blvd., Chicago 4. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 2.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, W. C. Bevington, 730 Indiana Pythian Bldg. Secretary, C. W. Stewart, 1001 York St.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, W. W. Stuart, 417 9th St. Secretary, E. O. Olson, Iowa State College, Ames.

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, D. M. Allen, 215 Pershing Rd., Kansas City 8. Secretary, R. E. Bade, 1102 Commerce Bldg.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, Einar Anderson, 152 Bannerman Ave. Secretary, F. T. Ball, 810 9th Ave., W., Calgary, Alta.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, C. W. Larson, 184 Sycamore St., Roslindale.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. President, J. J. Nolan, 78 Washington Ave. Secretary, W. E. Thorpe, 78 Washington Ave.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, W. H. Old, 1761 Forest Ave. W., Detroit 8. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, F. W. Legler, 17 W. 28th St. Secretary, F. H. Schernbeck, 1057 10th Ave. S. E.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets Third Monday. President, A. M. Peart, 637 Craig, W. Secretary, Leo Garneau, Room 832, Dominion Square Bldg.

Nebraska: Organized, 1940. Headquarters, Omaha. Meets, Second Tuesday. President, B. G. Peterson, 6235 Florence Blvd. Secretary, D. E. McCulley, 814 S. 14th St., Omaha 2.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, C. S. Koehler, 4374 Richardson Ave., New York 66. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, F. E. P. Klages, 1034 Jefferson Standard Bldg., Greensboro. Secretary, W. L. Hunken, 707 Guilford Bldg., Greensboro.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, L. C. McClanahan, 603 Great National Life Bldg. Secretary, E. J. Stern, 701 Burt Bldg., Dallas 1.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, O Meets, Second Monday. President, D. L. Taze, 1302 Swetland Bldg., Cleveland 15. Secretary, R. H. Cutting, 3795 Glenwood Rd., Cleveland Heights.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, E. T. P. Ellingson, 314 Savings Bldg., Oklahoma City 2. Secretary, G. T. Donceel, Oklahoma Natural Gas Co.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, A. S. Morgan, 156 Glenmanor Dr. Secretary, H. R. Roth, 57 Bloor St., W.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, E. C. Willey, Oregon State College, Corvallis. Secretary, G. H. Risley, 516 S. W. Oak St., Portland 4.

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, M. N. Musgrave, 2019 Third Ave., Seattle 1. Secretary, J. D. Sparks, 7331 W. Green Lake Way, Seattle 3.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, A. C. Caldwell, 550 So. 48th St., Philadelphia 43. Secretary, J. O. Kirkbride, Fourth and Locust Sts., Philadelphia 6.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, T. F. Rockwell, Carnegie Institute of Technology, Schenley Park. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, J. H. McCabe, 1730 Glenarm St. Secretary, F. L. Adams, P. O. Box 840, Denver 1.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, G. B. Rodenheiser, 4431 Finney Ave., St. Louis 13. Secretary, B. L. Evans, 571 Stratford Ave., University City.

South Texas: Organized, 1938. Headquarters, Houston, Texas. Meets, Third Friday. President, A. F. Barnes, 602 Kirby Bldg., Houston 2. Secretary, B. P. Fisher, Box 92, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Leo Hungerford, 3485 Wonderview Pl., Los Angeles 28. Secretary, Arthur Theobald, 336 North Foothill Rd., Beverly Hills, Calif.

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. President, H. G. Richardson, 1433 Harvard Ave. Secretary, E. V. Gritton, 2470 So. 15th East St.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, J. W. Markert, 8506 Garfield St., Bethesda, Md. Secretary, A. S. Gates, Jr., 111 County Rd., Kensington, Md.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. D. Bratt, 2259 Stafford Ave., S. W., Grand Rapids 7. Secretary, Frank Harbin, Jr., 181 West 21st St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, S. W. Strouse, 493 Franklin St., Buffalo 2. Secretary, G. E. Adema, 39 W. Balcom St.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, I. J. Haus, 3880 N. Richards St., Milwaukee 1. Secretary, M. W. Bishop, 231 W. Wisconsin Ave., Milwaukee 3.

Special Committees

Admission and Advancement: T. T. Tucker, *Chairman (one year)*; H. B. Hedges (*two years*); C. H. B. Hotchkiss (*three years*).

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*Member of Committee on Research.

Training Unit for Refrigeration Servicing

No. 2761—The "Viso-Trainer" has been developed to assist in demonstrating the proper methods of servicing refrigeration equipment of the Frigidaire Div., General

Motors Corp., Dayton 1, Ohio, and it is based upon a device used for several years in factory service training.

This trainer consists of a section of transparent bent glass tubing representative of the copper tubing used in an evaporator or cooling unit. The various gages and thermometers necessary for testing can be installed for the visual class reading. A connection is provided so that many types of refrigerant control valves and restrictors can be hooked into the apparatus.

By operating these valves either manually or automatically, actual refrigerant can be passed into the glass tubing, thereby showing students the exact appearance, movement, and results of liquid refrigerant and its conversion into a vapor. Thus, the functioning of various valves and the action of refrigerants are clearly demonstrated as they actually occur. By this means, typical service conditions and problems are duplicated before the students' eyes, and they are shown in a way that they cannot easily forget how such difficulties as oil logging, shortage of refrigerant, excess refrigerant, line restrictions, etc., are caused and can be corrected.

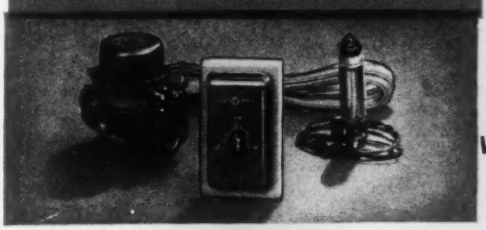
Flame-Resistant Chromate Gaskets

No. 2762—A new type of gasket consisting of a felt base, impregnated with a chromate pigmented compound "which renders the material flame and fire resistant as well as corrosion resistant" has been announced by the Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio. Originally intended as a substitute for low pressure rubber gaskets required in marine ventilating systems, chromate gasketing has since demonstrated its usefulness in many other applications, including joint seals in water, fuel oil, and diesel oil systems as well as gasketing for air lock and refrigerator doors, says the manufacturer.

Trimtherm

TOMORROW'S THERMOSTATS today!

- T-80 SERIES
  Trimtherm Thermostats are designed for all-gas control systems.
- ACCURATE REMOTE CONTROL
  of desired room temperatures.
- SURFACE MOUNTING
  with flush, streamlined appearance; no recess in wall.
- 1/2° DIFFERENTIAL
  Without false heat input.
- MODERN DESIGN
  Harmonize with room appointments.
- PLASTIC BASE
  Thermally isolates thermostat from wall.
- VISIBLE MARKINGS
  All calibrations easily read.
- ADJUSTMENT ON COVER
  No wall smear.



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● T-80 SERIES THERMOSTATS are also available in Package Sets, together with B-60 gas control with tamper-proof cover and integral pilot valve assembly; 30 feet of wire; and thermocouple pilot generator. *Everything needed,* in a convenient package, for quiet, safe, automatic control of central and floor furnaces, boilers, radiators, gas ranges and water heaters.

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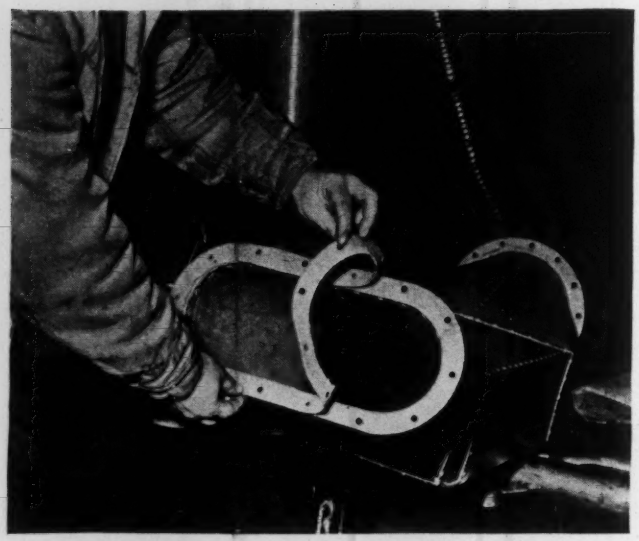


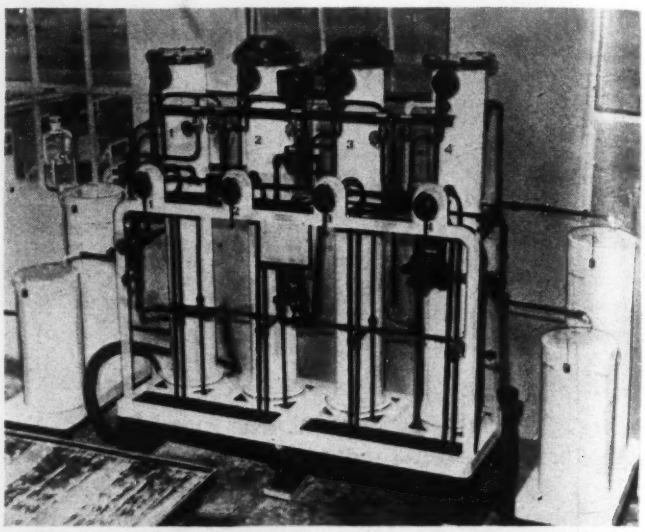
It can withstand relatively prolonged exposure to salt water without decomposition, and may be had either factory pre-cut or cut from sheet at the point of use without special tools. Thicknesses are 1/8 and 1/16 in.

Filtration Process Produces Chemical Equivalent of Distilled Water

No. 2763—Ordinary water can now be transformed into the chemical equivalent of distilled water by a simple filtration process, according to the American Cyanamid and Chemical Corp., 30 Rockefeller Plaza, New York 20, N. Y. Portable and stationary equipment designed for all types of users is available.

With these units, trade-marked "Filt-R-Stil," water which is virtually mineral free is made readily accessible for research laboratories; in electronic and electrolytic equipment fabrication; in the manufacture of textiles, leather, paper, pharmaceuticals, food, dyestuffs, and many other products; as well as in the filling of storage batteries.

The principle of the process is one of filtration by utilization of melamine-derived and other resins. Water is passed through beds of these ion exchange resins which transform the dissolved salts in the water to the corresponding acids and in turn absorb the acids. The process may be visualized by picturing water as con-



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TO FIT STANDARD 1/4" S.A.E. FLARED TUBE CONNECTION IN STANDARD LENGTH 24", 36" OR LONGER

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JACKSON, MICHIGAN, U.S.A.

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YOU enjoy immediate savings in fuel consumption, plus a substantial step-up in steam production, when you modernize with TODD burners.

Hundreds of plants have already modernized costly, inefficient boiler plants with TODD oil and gas burning equipment. *They report fuel savings up to 10% and more, with corresponding power increases.*

Operating economies like these are not unusual. For the over-all efficiency of the modern TODD burner, reflecting 30 years of sound engineering achievement, means *steam production at minimum cost*—a dollars-and-cents reason why NOW IS THE TIME TO MODERNIZE WITH TODD.

TODD combustion engineers are specialists in the modernization of industrial and commercial boiler rooms of all types. Why not call on them today . . . for an impartial survey of *your* plant . . . for suggestions, specifications, estimates. Their services are available at any time, without obligation.

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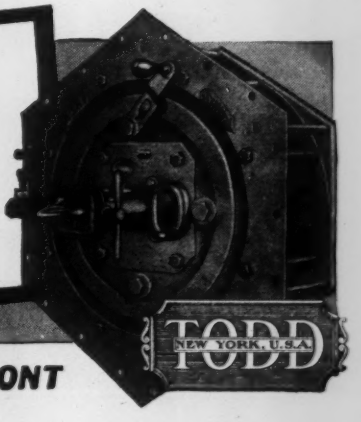

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FREEMAN
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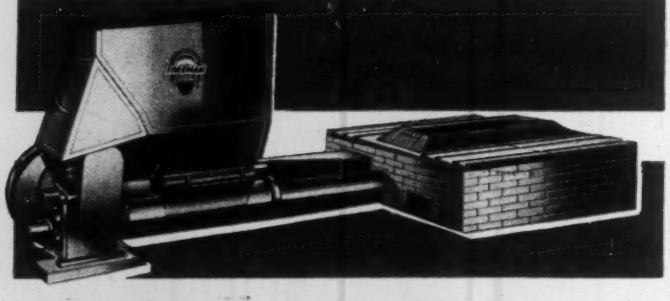
FIRST CHOICE OF AMERICA'S FOREMOST HEATING ENGINEERS



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ILLINOIS IRON & BOLT CO.
918 S. MICHIGAN AVE., CHICAGO 5, ILLINOIS

taining flowing metals which are attracted by a magnet except that the magnet, in this case, is chemical rather than electrical.

The final demineralized water has an average salts content as low as two parts per million as calcium carbonate, and has been produced as pure as one-half part per million, says the manufacturer. The process also removes dissolved carbon dioxide from the water, a feature of particular importance in its use in the electronic and electrical fields. So effectively has water been cleaned of its minerals that its specific resistance to an electric current has been increased to as much as 6,000,000 ohms.

Air Conditioning Multiroom Buildings

No. 2764—New patents for the control of indoor climate in multiroom buildings through a "Conduit Weathermaster" air conditioning system have been issued to Carrier Corp., 302 S. Geddes St., Syracuse, N. Y., Dr. Willis H. Carrier announced recently. Speaking before a group of editors and writers, he declared the system would open up "vistas in the economic and social avenues of human progress which may do much to change our mode of life." He said that the system takes up less room for conditioning equipment than do other systems; that it completely eliminates return air ducts from the rooms, heretofore used in most systems, and reduces the air supply ducts to conduits the size of a plumbers' waste pipe; and that it enables any number of rooms, supplied from the same central conditioner, to be individually heated or cooled to suit the needs or desires of different occupants.

The system is essentially as follows, Dr. Carrier said:

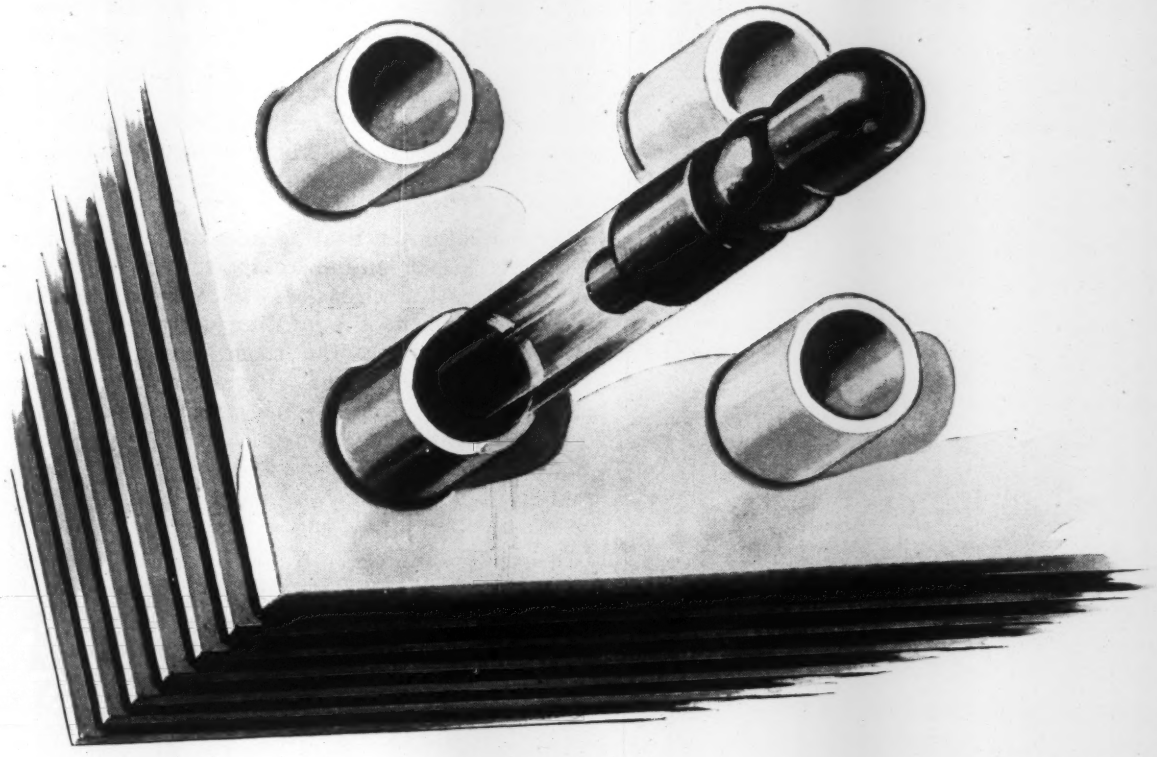
1) It provides a central air conditioning apparatus about one-third the size required by other systems.

2) The air which is heated and humidified, or cooled and dehumidified, in the central apparatus, is exclusively outside air. This is only about 20 per cent of the total air required for proper circulation in the conditioned rooms.

3) Small high pressure fans discharge this conditioned air at static pressures and velocities much higher than heretofore considered practical. Air velocities as high as 4000 fpm are usually employed or about two and one-half times the duct velocity allowable in conventional systems.

4) Due to the small volume of conditioned outdoor air and because of the high velocities employed, air conduits instead of ducts may be used, the areas of which are one-sixth that required "with our own best previous system" and about one-half of that employed in conventional duct systems. These conduits, replacing riser ducts, are for the average installation about 6½ in. in diameter for the largest size and are reduced in diameter for most part to about 4 in.

5) Each room is equipped with a "Weathermaster" unit (illustrated) which replaces the conventional radiator, but which serves the room throughout the year. The high velocity air enters this unit and is discharged through a series of small nozzles so designed that despite air velocities of 4000 fpm, no noticeable noise results. The discharge of this air through the unit induces air from the room to enter the unit in volume about four times as great as the conditioned air. The



HOW A BULLET CREATES A BETTER HEATING UNIT

THE SECRET OF THE CONSTANT SERVICE AND LONG LIFE OF TRANE COILS

A bullet actually builds a road for better heating in the Trane Extended Surface Heating Coil. In a heating coil—whether used in a unit heater, convector, air conditioning unit, or in a central heating system—the bond that permits heat to escape from steam is important.

That bond not only serves a structural purpose but it also creates the pathway on which heat moves from the steam or hot water in the coil to the space you want to heat. If the path is partially or wholly blocked, the path of heat-flow is obstructed. As a result, the coil does not deliver its rated capacity. If any part of the path is weak and crumbles away, heat has difficulty in jumping the gap. And the coil breaks down before its time.

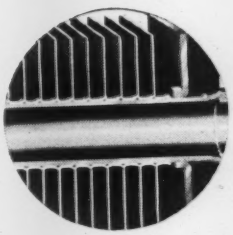
Because the bond is so important, Trane has spent long years in research to develop a perfect union. The marrying parson is a bullet. Seamless copper tubes are placed in the specially collared openings of flat metal plates called fins. A bullet is then actually shot through the tube.

The action of the bullet expands the copper tube into the collars of the fin to form a permanent mechanical bond. A strong man with a pair of pliers would have difficulty in pulling the fin away from the tube once the bullet has done its job. Yet, no paste, adhesive, brazing material or other foreign substance is used.

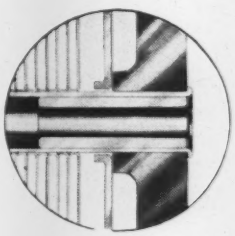
In the Trane Coil, the road for the heat to travel is wide open, and like the Appian Way, it's built to last. That's why you can get rated capacity from Trane Coils day in and day out for years.

There are six Trane Coil types for steam at various pressures and for hot water. Hundreds of sizes are available to provide a coil for every use. Some Trane Heating Coils may even be used for cooling purposes when their heating tasks are completed. Write for Trane Catalog DS-385 now!

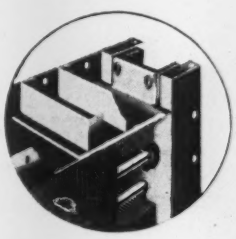
Also write for your copy of the new TRANE POST WAR PRODUCTS BULLETIN.



A cross-section view of a Trane Coil showing tube and fin construction. Note that each fin or plate is formed not only to make contact with the other tube, but also with the adjacent fin. Heat from the tube can travel out over many interconnecting pathways. Another Trane Coil feature to give top heating performance.



The guardian against leaks is the husky brass bushing that reinforces the tube and header joint. Tube is rolled into an accurately reamed header opening. That makes a tight joint. But for double protection, the joint is permanently sealed by the brass bushing.



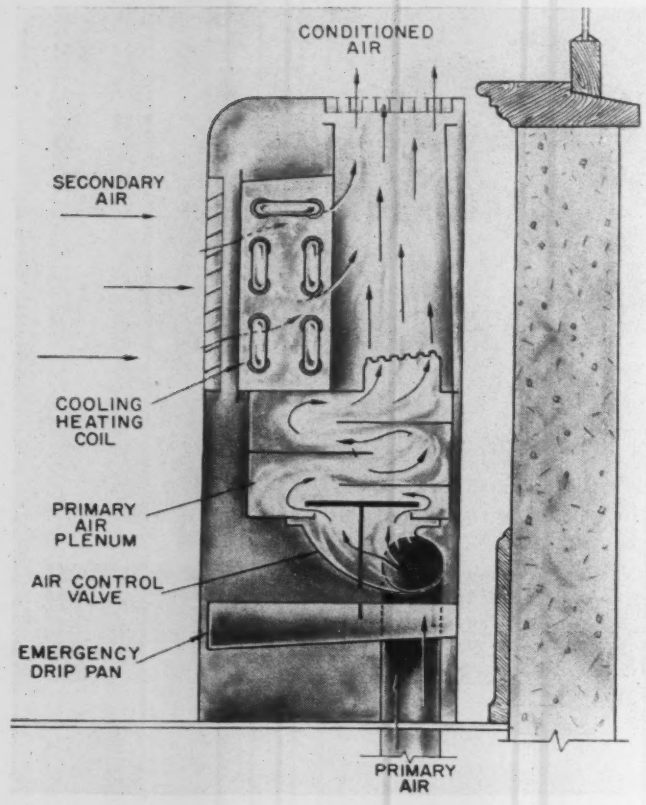
So that the coil can float in its casing, Trane uses its Guide Flange Assembly Feature. The coil can expand and contract without stress or strain on casting or any other part. This removes the possibility of tube strain.

TRANE

THE TRANE COMPANY • LA CROSSE, WISCONSIN

TRANE COMPANY OF CANADA, LTD., TORONTO

AIR CONDITIONING • HEAT TRANSFER • AIR HANDLING EQUIPMENT



induced air mixes with the conditioned air and the mixture of 20 per cent conditioned outside air and 80 per cent induced room air leaves the unit at a relatively small velocity but in sufficient volume to provide gentle but adequate air movement throughout the room. The volume circulated is always constant, which is very desirable.

6) Each room unit is provided with a supplementary conditioning device for heating or cooling the air as may be desired. In fact the greater part of air treatment, whether heating or cooling, may take place in the room. This is controlled by the "Thinking Valve" which regulates the heating and cooling action of the unit. Since each unit is equipped with such a valve, which automatically regulates the admission of heating or cooling fluids to the unit, an occupant may set the valve to get exactly the room temperature wanted. Therefore, one room may have its valve produce a temperature of 80 deg while an adjacent room may have 70 deg, to suit a particular occupant. The control is equally effective winter and summer and may be regulated so that it will give a desired lower temperature, for example, at night, and a temperature, say, 10 deg higher during the day.

7) No recirculated air is employed; this eliminates return ducts. Thus, there is no danger of contamination as may occur where the air from one room is returned to another.

Oil Burners

Use of March 1942 prices as the basis for pricing new household and commercial oil burners, when production is resumed, was discussed at the first formal meeting of the OPA's recently appointed oil burner industry advisory committee in Washington, D. C.

THE BIG BLIZZARD
before
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It began the day after New Years, 1879 . . . one of the worst storms in American history. It was a cold winter — but there was warming news for steam plant operators that year when the founder of this company introduced the world's first steam trap. For 66 years since then, Tim Kieley and his family have continued to pioneer and perfect steam specialties and pressure and flow controls. Speaking of cold winters, here's a K & M Diaphragm Motor Valve for any extremes of temperature, very low or very high. This precision device, with its finned bonnet, gives control of steam, liquids, gases or air within 1% of initial pressure. Write for Catalog No. 66, which gives full descriptions, specifications and capacities of this dependable Kieley & Mueller No. 488 Valve.

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Alnor
VELOMETER

The Alnor Velometer

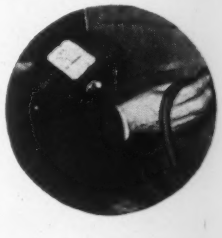
the only instantaneous, direct reading Air Velocity Meter

The only quick, convenient direct-reading means of checking air motion in ventilating, drying, air conditioning, and similar installations is with the Alnor Velometer. This instrument gives reliable information so easily that engineers and service men are encouraged to take complete data, for correct and efficient operation.

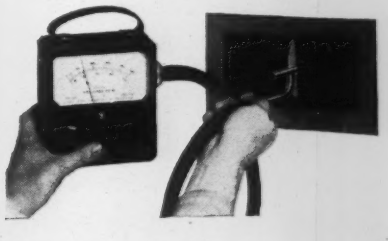
With the Alnor Velometer instantaneous direct readings of air speed are measured in feet per minute. With it checking draft, leaks around doors and windows, or in ducts, measuring velocities at outlets or in ducts, is simple and convenient. Anyone can use the Velometer—without calculations, leveling, timing, or other time-consuming conversions.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm, and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25,000 fpm velocity and 20 inches pressure. Extension jets permit accurate readings in many locations that would be completely inaccessible with other means of measurement. Write for Velometer Bulletin.

Velometer used for positive static pressure readings



Checking return grille reading with Velometer and suction type jet



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420 NORTH LA SALLE STREET, CHICAGO 10, ILLINOIS

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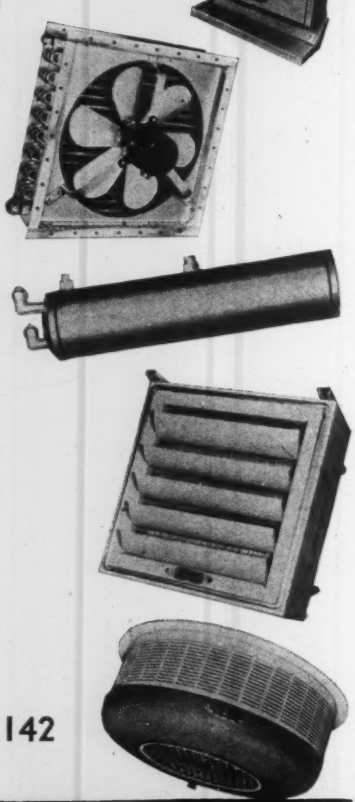
HEAT TRANSFER PRODUCTS FOR POST-WAR RECONVERSION

AMERICA'S rising standard of living will make increasingly greater demands upon the skill of refrigeration.

Inevitably the refrigeration industry will seek creative ideas and new structures in heat transfer in order to satisfy those demands.

We are ready.

WRITE FOR CATALOG R142



KRAMER TRENTON CO.
TRENTON, S. N. J.

• WPB . . . OPA . . . PAW . . . Etc. •

[*See page 24, main editorial section, for further information*]

Asbestos Fiber

Restrictions on the use of South African asbestos fiber have been removed through revocation of section (b) of conservation order M-79, the WPB reported December 8. Slackened demand for the long fiber Rhodesian asbestos, particularly in naval requirements for heating units, and increasing supplies prompted removal of these restrictions, officials of the cork, asbestos and fibrous glass division said. This action eliminates the need for reports on form WPB-2916 and related forms PD-251, PD-252, and PD-253.

Fans

Production of propeller type electric fans under limitation order L-176 for essential hospital, institutional, and industrial purposes was expected to fall short of the estimated requirement of 100,000 for 1944 by about 25 per cent, WPB representatives said at the recent meeting of the domestic and commercial electric fan industry advisory committee, WPB reported December 8. This estimate of 1944 production under L-176 was obtained through manufacturers' reports and a recent check by WPB of fan manufacturers concerning expected fourth-quarter production, WPB representatives said. They added that manufacturers said their inability to step up production to the needed rate was caused principally by the manpower shortage and delays in delivery of materials and components.

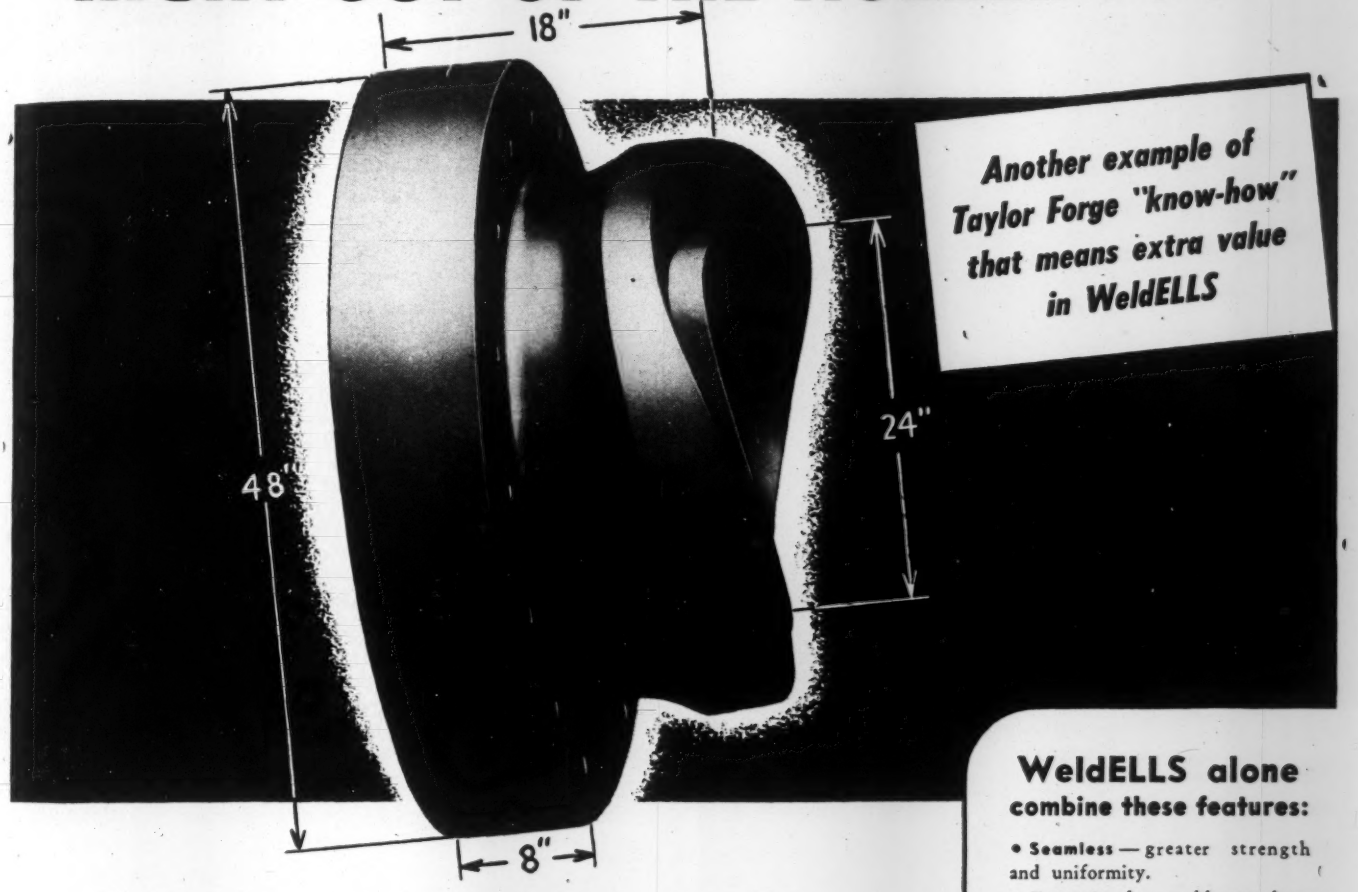
A fan production program for essential hospital, institutional, and industrial purposes for 1945 had not yet been approved, WPB officials said. They reported, however, that military and export requirements for shipboard fans are expected to total at least 223,000 and perhaps almost double this number.

Housing

Formation of an architectural advisory committee to guide and assist the Federal Public Housing Authority, local housing authorities, and any others interested in the design and development of low cost housing for the future was announced last month by Philip M. Klutznick, FPHA commissioner. The committee has been initially organized under the chairmanship of Howard Myers, publisher of Architectural Forum, with William W. Wurster, dean of the school of architecture at the Massachusetts Institute of Technology, as vice-chairman. Membership will consist of representatives of the architectural and engineering professions and of local housing authorities.

The committee will undertake independent studies of the design and development of low rent projects under the Federal Public Housing Authority and its predecessor, the United States Housing Authority, and evaluate this experience on the basis of ideas and designs that should be incorporated or expanded in future low cost housing and of mistakes to be avoided or experiments which should be abandoned or modified.

RIGHT OUT OF THE NOZZLE . . .



★ *Walk into any big, modern oil refinery or power plant and the chances are you will find Taylor Forge nozzles like the one pictured above providing safe, full strength outlets on high pressure boilers and pressure vessels. This is no coincidence. As America's first maker of fully reinforced pressure vessel outlets, Taylor Forge has built up a fund of technical information on the complicated subject of stress conditions in such vessels, and engineers have learned to draw heavily upon our experience and knowledge in designing for full strength.*

NOZZLES like the above bring the steam or other fluid out of the boiler or pressure vessel, but from there on the job is taken over by the piping system. And here, too, Taylor Forge "know-how" and experience play an important part. For this knowledge has resulted in a very nearly ideal line of Welding Fittings.

Yes, WeldELLS and other Taylor Forge Welding Fittings are *designed* for the job they are to do . . . designed to provide safe, long lived and economical piping.

Just take a moment, please, and check the list of features opposite. Are there any you would omit? Can you think of any you would add?

That's why we say WeldELLS are very nearly ideal—why you can be sure that

WeldELLS have everything

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

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If this Housing ever Breaks or Distorts we will replace it Free
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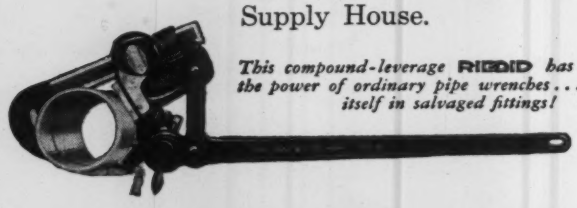
● It's no accident that the RIDGID is the favorite pipe wrench of millions of expert users. That unconditionally guaranteed housing that won't break or warp means years of repair-free service. Adjusting nut in open housing spins easily to pipe size. Quick-action jaws won't lock on pipe—handy pipe scale on full-floating hookjaw. Strong comfort-grip I-beam handle. More for your money—and you enjoy using it. Buy it at your Supply House.



This compound-leverage RIDGID *has 14 times the power of ordinary pipe wrenches . . . pays for itself in salvaged fittings!*

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY, ELYRIA, OHIO, U. S. A.

Plastic Pipe Nipples

Specific ceiling prices for all manufacturers' sales of "Saran" plastic pipe nipples were announced by the OPA, effective December 2, 1944. The prices range from 58 cents for a 3 in. nipple to fit a ½ in. pipe, to $2.94 for a 12 in. nipple to fit a 2 in. pipe. These prices are the same as those contained in a recent individual OPA order, authorizing maximum prices submitted for approval by the first concern to start fabricating the plastic nipples. Since the individual order was issued, other manufacturers have filed for approval of maximum prices. The proposed prices submitted for approval are the same as those approved in the previous order.

The action designates the same discounts and freight allowances set forth in provisions governing prices of "Saran" pipe, tubing, and pipe fittings, to apply in establishing resellers' ceilings for nipples. Maximum prices at all levels of distribution for the pipe, tubing, and fittings, were issued on August 3, 1943. (Amendment No. 64 to order A-1 under section 1499.159b of maximum price regulation No. 188—specified building materials and consumers' goods other than apparel—effective December 2, 1944.)

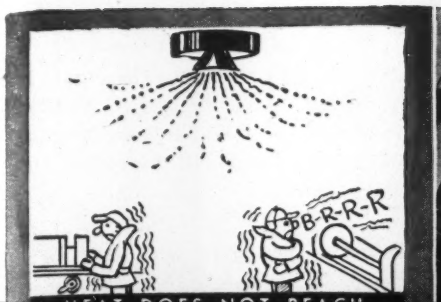
Lead

The WPB announced December 27 that most civilian uses for lead will be restricted to the annual rate of 60 per cent of the 1944 level through a complete revision of order M-38. The recently announced critical supply position of the metal, a result of mounting military demands, declining production, and a dwindling government stockpile, required this action, officials of the tin, lead and zinc division said. Government officials reported that estimated 1945 requirements are 1,150,000 tons as compared with 970,000 tons of total supplies. Government reserves are less than one month's consumption and have been decreasing at a rate of from 15,000 tons to 25,000 tons per month during the last five months.

Restrictions and availability of lead are defined in the revised M-38 order under three new lists. List A outlines all prohibited uses (with certain minor exceptions). List B classifies the end uses for storage batteries, cable covering, tetraethyl and ammunition for military use only, for which lead will be 100 per cent available. Lead will also be unrestricted for solders, bearing metals, brass and bronze. Under list C, which embraces the greater portion of civilian uses, lead is restricted in the first quarter of 1945 to 30 per cent of the amount used in the first half of 1944, or at a 60 per cent annual rate.

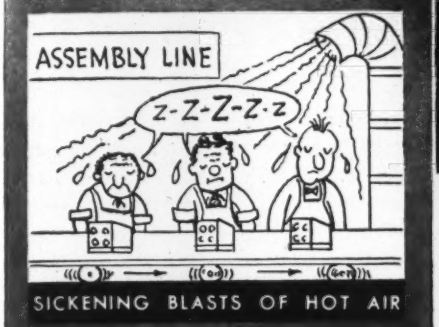
Stoker Pricing

Use of March 1942 prices as the basis for pricing new household and commercial stokers, when production is resumed, was discussed at the first formal meeting of the OPA's recently appointed stoker manufacturers' industry advisory committee in Washington, D. C. The committee elected permanent officers and formed a task committee that will help draw up a cost questionnaire to be sent industry members to determine what price adjustments may be necessary.



HEAT DOES NOT REACH WORKING ZONE

UNCOMFORTABLE RADIANT HEAT

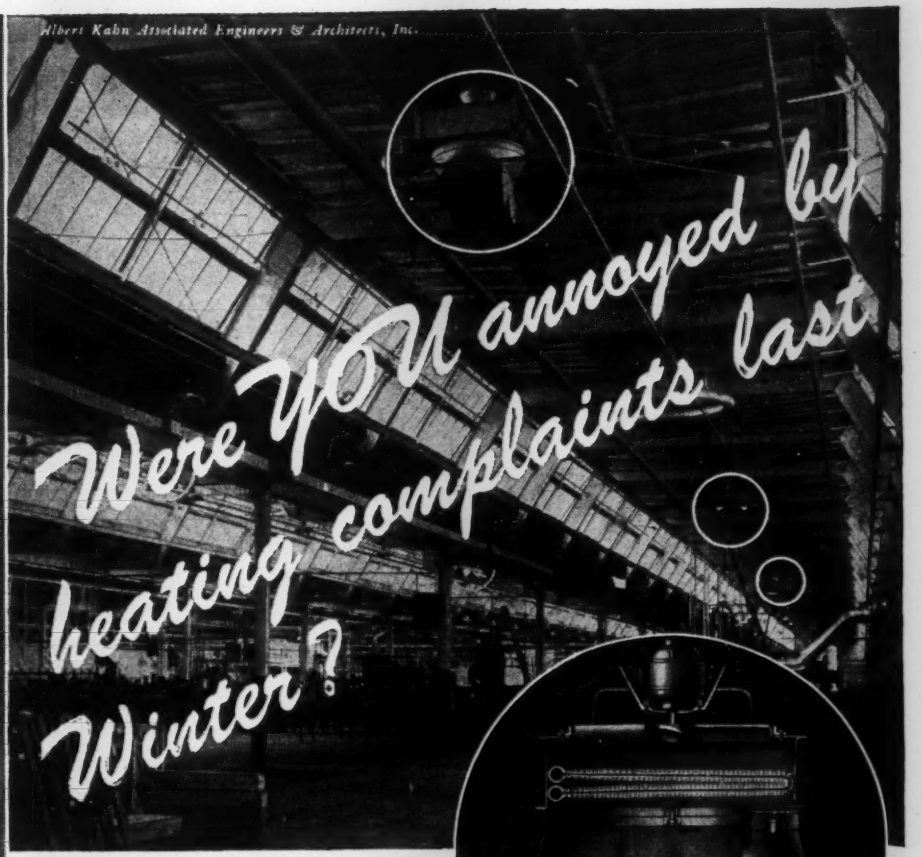


SICKENING BLASTS OF HOT AIR

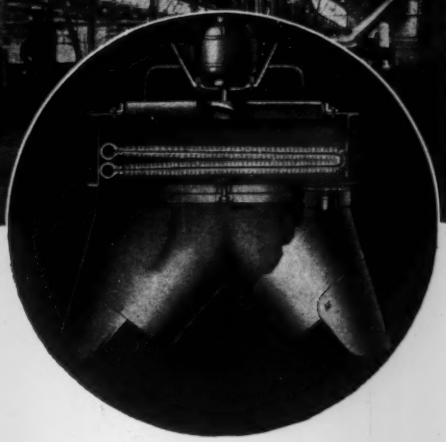
COLD INTAKE DRAFTS ON FEET
HOT DRAFTS ON THE HEAD

SOME WORKERS TOO HOT WHILE OTHERS ARE TOO COLD

Albert Kahn Associated Engineers & Architects, Inc.



(Above) Installation of 63 Wing Revolving Unit Heaters in Plant of Automotive Appliance Manufacturer



Cross-sectional view of WING Revolving Unit Heater, showing Motor, Fan, Heating Element and Revolving Discharge Outlets.

The objectionable features of heating systems like those cartooned at the left are the cause of endless complaints.

WING *Revolving* HEATERS

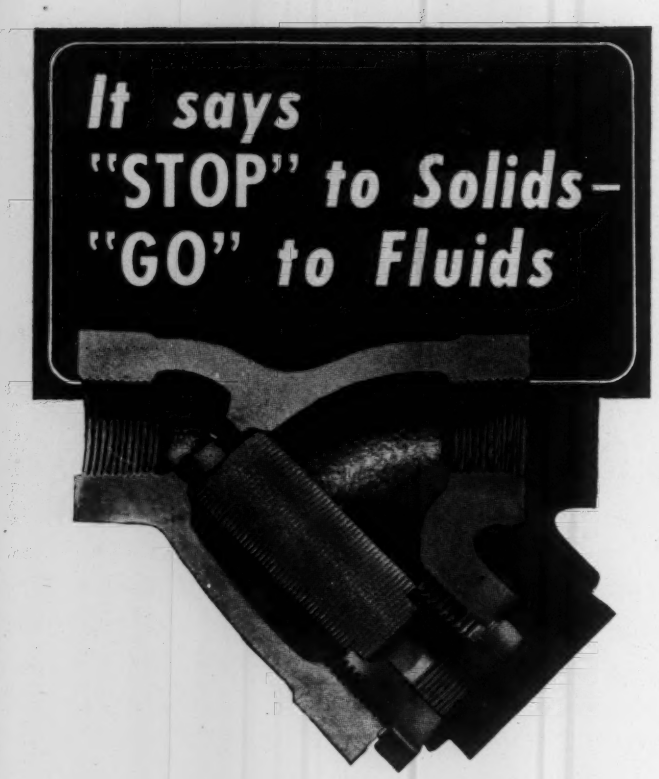
ELIMINATE HOT SPOTS AND COLD SPOTS

Located at roof or ceiling, they revolve slowly, projecting the heated air to the working level in moving streams which sweep slowly through 360 degrees, covering successively every direction instead of constantly in some one direction. The gentle air motion and the thorough coverage bring a sensation of fresh, live, invigorating warmth to workers. **And in the Summer, with the steam turned off, they create a delightful cooling effect that is equally effective in stimulating production.**

Write for Bulletin HR-3

L. J. Wing Mfg. Co., 14th St. and 7th Ave., New York 11, N. Y.

Factories: Newark, N. J. Montreal, Canada



A BETTER Strainer to "police your pipelines"

- **FIRST**—*The Screen*, a high-grade woven Monel wire basket that catches solids—lets condensate, oil or other fluids flow freely.
- **SECOND**—*Finish*. Cadmium plated inside and out for protection against corrosion.
- **THIRD**—*Easily Cleaned*. Blow-off bushing made for easy removal. Bushing and Screen come out together. Screen automatically aligns on reassembly.
- **THOUSANDS IN SERVICE**—Sold by over 100 Mill Supply Houses.

6 sizes from ½" to 2" for pressures up to 600 lb. Reasonably priced. See your supply house or write for Bulletin S-200.

YARNALL-WARING COMPANY
107 MERMAID AVENUE • PHILADELPHIA 18, PA.

Construction Volume

Preliminary estimates of new construction put in place during the year 1944 indicate a volume of $3,840,000,000, compared with the $3,900,000,000 programmed for the year in August 1943, the WPB reported December 12.

This volume is not quite half the 1943 total of $7,732,000,000 and less than one-third the 1942 peak activity of $13,434,000,000, WPB said.

Work financed by public funds accounted for only 61 per cent of the 1944 total activity as contrasted with nearly 80 per cent in 1942 and 1943. Activity volume for all major types of construction was less in 1944 than in 1943 with the sharpest decrease occurring in military construction (troop housing, airfields and bases, storage facilities, etc.), which declined to $730,000,000 from the $2,423,000,000 volume of 1943.

Construction volume at government-financed industrial plants reached $735,000,000 for the year. This governmental industrial work represents only 37 per cent of the 1943 activity and 21 per cent of the factory volume of 1942. Deliveries of machinery and equipment to government-financed plants in 1944 were down to 35 per cent of the 1943 rate.

New housing activity in 1944 amounted to $685,000,000, slightly more than half the 1943 volume, with the biggest drop occurring in the government-financed segment, which was down to 27 per cent of the 1943 volume. All other non-industrial construction—comprising highways, community buildings, sewer and water, conservation, utilities, farm and other non-residential work—registered a volume of $1,505,000,000 in 1944, or 84 per cent of the 1943 volume. Private work in this category (farm, utilities, and community buildings such as hospital, educational, and social and recreational structures) totaled $804,000,000, which was 8 per cent over the activity for these types during 1943; publicly-financed work was down 33 per cent from the 1943 level with the sharpest declines occurring in highways, conservation work, and public pipe line construction.

Stokers

In line with the program to prevent added civilian production from interfering with essential war output, members of the stoker manufacturers industry advisory committee were advised that authorizations for the first quarter of 1945 under the regular program would be subjected to a more critical review than was the case early in the fourth quarter, WPB announced December 18.

It appears that authorizations will be granted for the production of class A stokers for the first quarter of 1945 on about the same basis as production of these sizes in the third and fourth quarters of 1944, according to the Stoker Manufacturers Association on December 20. A survey completed by the association shows that on December 1, the industry had an unfilled backlog of class A orders of approximately 14,000 stokers, the greater portion of which were in the range of sizes from 65 to 150 lb of coal per hr.

Old King Cole was a merry old soul because he "knew his musicians" when he called for his fiddlers three. The reliable plumber and contractor can also become a "merry old soul" . . . and a thrifty one . . . by calling for the highest grade fittings from only responsible jobbers.

"K" fittings are precision cast and precision machined. Inspection controls "eagle eye" them step by step, from cupola to stock bins. That is why they make up fast, pull tight and reduce costly callbacks to a minimum. Ask for "K" fittings.

COMPLETE LINE. CATALOG ON REQUEST.

Standard and extra heavy cast iron screwed fittings. • Standard flanged fittings. • Standard and extra heavy companion flanges. • Drainage fittings.

KUHNS BROS. CO.
DAYTON 7, OHIO.

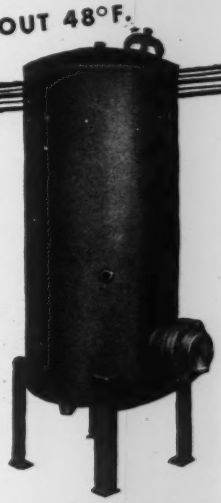
"K" fittings carried in stock at Malleable Iron Fittings Co., Branford Conn.; M.I.F. stocks at Kuhns Bros. Co., Dayton, Ohio.

PROPOSAL FOR
M. M. Mc Millinney, Inc.
SUBJECT

SEVEN SMALL INSTANTANEOUS WATER HEATERS TO HEAT THE SPRAY WATER FOR HUMIDIFICATION CONTROL IN AIR CONDITIONING PLANT.

TWO LARGE HEAT EXCHANGERS WITH 1560 SQ. FEET OF SURFACE EACH TO COOL CIRCULATING WATER TO TEMPERATURE OF ABOUT 48°F.

GET ADSCO'S PROPOSAL on your Heating or Cooling Problems



ADSCO VERTICAL STORAGE HEATER

Typically, the wide range of application for ADSCO Heaters and Coolers is the equipment covered by the above proposal.

These heaters are now in operation—and are doing an outstanding job because they were designed to meet the exact requirements of this particular installation.

Whether you require horizontal or vertical, storage or instantaneous equipment to heat or cool water, gases, oil or other liquids, take advantage of ADSCO'S 65 years of experience in the design and construction of this type of equipment.

ADSCO equipment is built just right for your job—with the capacity and reserve requirements necessary for most efficient operation. Put your heat exchange problem up to us or write for Bulletin Number 35-75.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, NEW YORK
Makers of "UP-TO-DATE" Steam Line Equipment For Over 65 Years

RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 211. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending in your request to Heating, Piping & Air Conditioning.

Automatic Valves and Pressure Controls

No. 4859—28 p. descriptive catalog on the complete line of "Cash-Acme" automatic valves and pressure controls for use with water, air, steam, and oil.—A. W. Cash Valve Mfg. Co., 666 Wabash Ave., Decatur, Ill.

Care and Handling of Heat Exchangers

No. 4860—12 p. booklet on the care and handling of heat exchangers, with many helpful hints on the efficient use of heat transfer equipment. Installation, operation, maintenance, cleaning, and corrosion are discussed.—Whitlock Mfg. Co., 100 South St., Hartford 1, Conn.

Copper Base Alloys

No. 4861—80 p. manual of information on "Duronze" high strength, corrosion resisting, copper base alloys, describing the five types which are available and with a wealth of data on general characteristics, physical properties, ASTM specifications, federal specifications, applications, machining, welding, etc.—Bridgeport Brass Co., 30 Grand St., Bridgeport 2, Conn.

Corrosion

No. 4862—54 p. publication comprising a convenient and comprehensive analysis of corrosion principles for both the practical man and the technician in the metal field. An opening section explains how corrosion processes work, and discusses the known factors that influence their action: acidity of solution, oxidizing agents, temperature, agitation, films, inhibitors, surface condition, stress, heat treatment, welding, concentration cells, and galvanic action. The detailed review of testing methods that follows tells how service conditions are simulated in corrosion research. Included is a description of the construction and use of the well-known spool-type specimen holder for determining the comparative behavior of several metals and alloys simultaneously under actual operating conditions. The applicability of "Monel," nickel, and "Inconel" in various corrosive media is analyzed in the closing section. Tables list nearly 500 typical corrosives in which these alloys have been successfully used, and report the results of more than 120 specific tests under varied conditions in 44 common corrosive agents.—International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

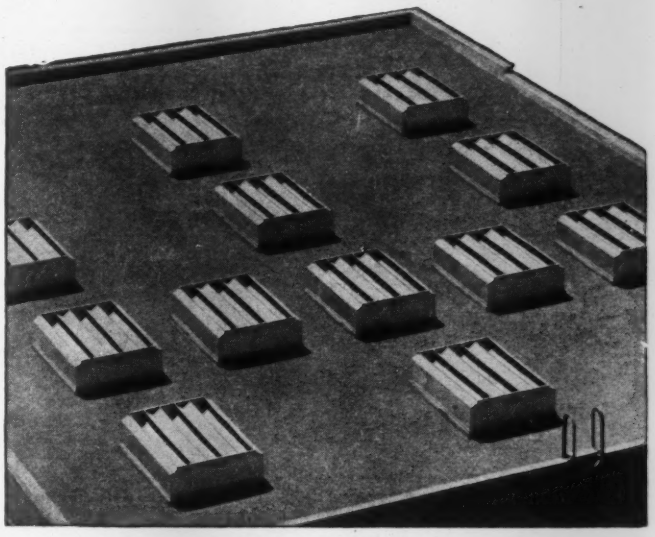
Electrically Operated Switches

No. 4863—16 p. circular (600) on "Asco" electrically operated switches—automatic transfer switches, remote control switches, and contactors and relays. Features are described and illustrated, and operating principles are shown.—Automatic Switch Co., 41 E. 11th St., New York 3, N. Y.

Look before you leap! Don't jump into any post-war proposition on oil heaters until you've surveyed the entire field. Remember the excellent past performances of QUIET MAY before you get excited about any rosy promises now on the horizon. QUIET MAY isn't shouting now—QUIET MAY is simply getting ready for tomorrow—today.

The proven and dependable Dual Utility Oil Heating Unit will be included in the line when we resume production.

May Oil Burner Corporation
Baltimore-3, Md.



How to achieve high efficiency in roof ventilation without high ventilator construction...

These 7'6"x 10'

AIRMOVERS

are equal in capacity to 74-inch round ventilators

Here's capacity that surprises you, appearance that pleases you—Swartwout's revolutionary new AIRMOVER, efficient gravity flow roof ventilator that's only 32 inches high. Spot them wherever you need direct heat and fume removal, just as you've used conventional round type ventilators. Low and flat—no "top heavy" appearance.

For general ventilation, AIRMOVER in continuous runs can cover as much roof as necessary.

Swartwout's experience with many war plant installations has refined the technique of manufacturing and installing this latest *Natural* type roof ventilation.

Ask for installation examples and details of the AIRMOVER.

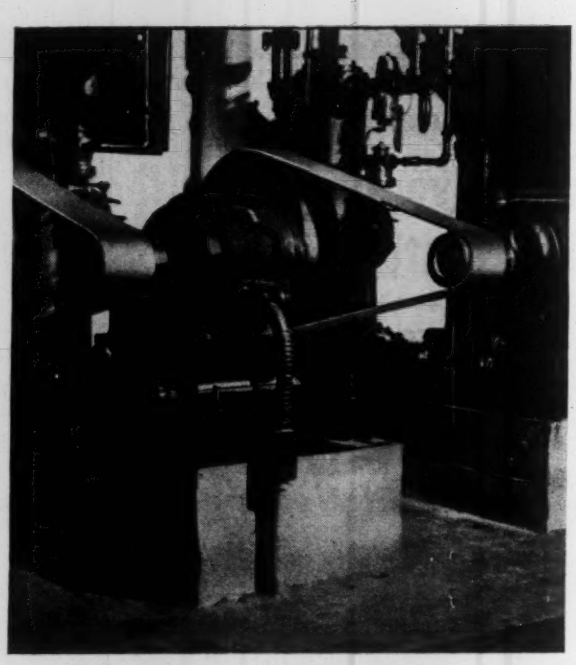
THE SWARTWOUT COMPANY
18511 Euclid Avenue, Cleveland 12, Ohio

Swartwout

Specialists in Air Movement by *Natural* Methods

The Air Conditioning Equipment Drive
for Long, Trouble-Free Service

Tannate-Rockwood



The automatically controlled belt tension provided by the weight of the motor on the Rockwood Pivoted Motor Base keeps efficiency high at all times. This is further aided by the firm grip of the Tannate Leather Belt which assures smooth running and a steady pull.

Because Tannate also has exceptional flexibility, strength and endurance, the life of the drive is long . . . with practically no maintenance.

Write us for further details.

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PRODUCTION DRIVE

—Established 1702—

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Pumps

No. 4864—8 p. bulletin (44-4620) on vertical multistage pumps for handling hot or cold, corrosive or noncorrosive, liquids where the net positive suction head is limited. Illustrations are shown of pumps handling light petroleum fractions, in condensate return service, and for heater drip piping. Capacities to 1000 gpm against heads up to 250 psi are available in standard sizes, with pumps on special order to 5000 gpm and for subzero temperatures or to 750 F.—Byron Jackson Co., Pump Div., P. O. Box 2017 Terminal Annex, Los Angeles 54, Calif.

Stokers

No. 4865—8 p. bulletin, entitled More Steam at Less Cost, describing the "AE Perfect Spread" stoker, with photographs, cross-sections, and drawings. Designed to burn all kinds and grades of solid fuels thoroughly, wet or dry, according to the manufacturer.—American Engineering Co., Aramingo Ave. & Cumberland St., Philadelphia 25, Pa.

Vacuum Cleaners for Furnace and Boiler Cleaning

No. 4866—4 p. descriptive bulletin (117) on portable vacuum cleaners for furnace and boiler cleaning, illustrating the use of and giving specifications for these units.—Spencer Turbine Co., 486 New Park Ave., Hartford 6, Conn.

Fuel Conservation

Pointing out that because of fuel shortages many householders may be obliged to reduce the heat level in their homes in midwinter unless they conserve fuel during the early part of the heating season, Dr. Thomas Parran, Surgeon General of the Public Health Service, Federal Security Agency, said November 30 that "starting with the usual luxury level of heat now is a practice that should be avoided."

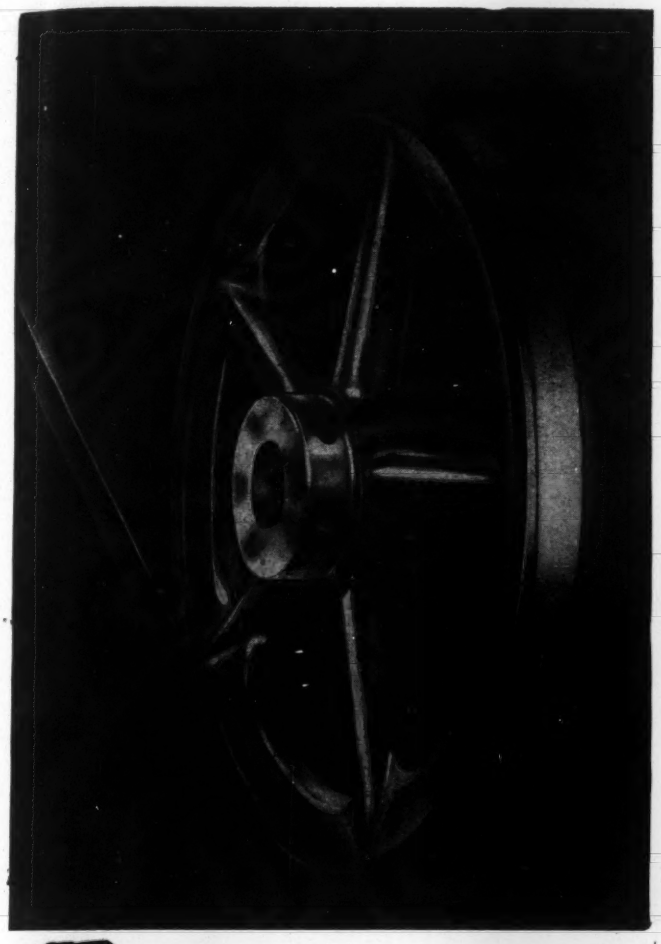
"Since the human body adjusts without injury to extreme cold, provided the transition is gradual and clothing is adequate," the Surgeon General said, "it is the part of wisdom to start with a low temperature and maintain it steadily.

"People forget that the comfort level of room temperature can be reduced substantially before the danger level is reached.

"The so-called comfort level is about 68 to 70 F. The average indoor temperature of private dwellings and office buildings frequently runs 75 deg and above in cold weather. These temperatures are needlessly high and one can learn to be perfectly comfortable in temperatures between 60 and 65 if one is well, properly clothed, properly fed and reasonably active.

"In the past, we have heated the whole house to suit the members of the family wanting the highest temperature level. The better plan is to maintain a consistently lower temperature and to provide warmer clothing for those needing protection, or separate warmer rooms for infants and invalids needing extra heat."

FIGHT FUEL WASTE



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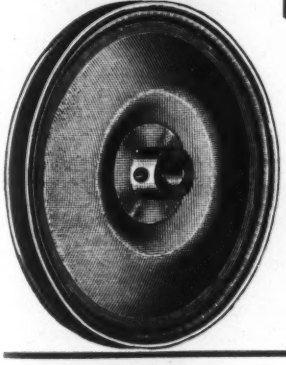
provide a L-O-N-G step toward TROUBLE FREE Performance

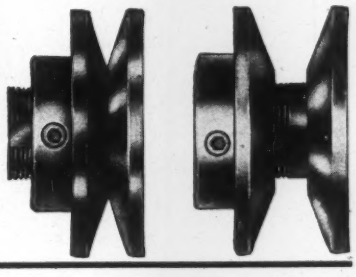
Our long experience in designing and manufacturing V-Pulleys, our complete understanding of their uses, and the finest materials—all are combined in making Maurey V-Pulleys the very best Pulley installations for Refrigeration and Air Conditioning systems as well as for Fans and Blowers.

For unfailing, continuous operation be sure to specify Maurey V-Pulleys.



MAUREY MANUFACTURING CORP.

2915 South Wabash Avenue
CHICAGO 16, ILLINOIS



Profit$ for You!

More Warmth and Fuel Economy for Your Space Heater Customers

A-P Thermostatic Temperature Controls are Designed for ALL Oil-Burning Space Heaters Using A-P Model 240-DR or UR Manual Controls . . .

Oil-burning space heater users need your guidance to get more heat and comfort from their fuel oil allotment — avoid fuel waste and overheating, prevent cold homes in the early spring.

Contact all your space heater customers — win their continued patronage and friendship by suggesting an A-P Thermostatic Control Set for their present heater to conserve oil.

SELL THIS COMPLETE SALES PACKAGE — EASILY INSTALLED

The A-P Thermostatic Temperature Control Set is a complete sales package — including an Electric Conversion Top, accurate wall thermostat, transformer, wiring, staples and full instructions. Returns more than its cost in fuel savings and positive comfort — easy to install.

NOW is the time to get behind this vital and profitable sales promotion. Ask for bulletin and prices on A-P Thermostatic Heat Regulator Set No. 240-ED.

AUTOMATIC PRODUCTS COMPANY

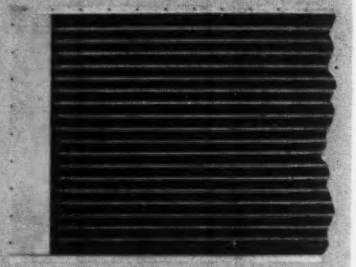
2460 N. THIRTY-SECOND STREET • MILWAUKEE 10, WIS.

DEPENDABLE OIL CONTROLS

McCORD
HEATING AND
AIR CONDITIONING
PRODUCTS

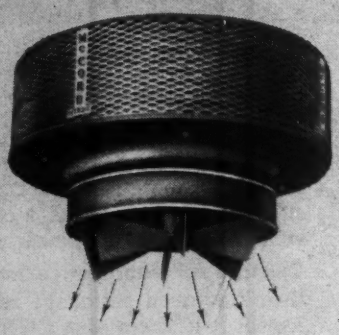
BLAST HEATING COILS
AIR CONDITIONING COILS
ALL TYPES

McCord spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded.



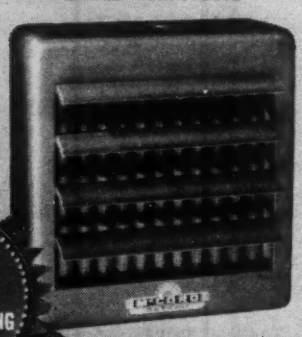
VERTICAL TYPE
UNIT HEATERS

A tried and proven heating unit, modern in design. McCord spiral fin tube construction creates air turbulence without undue restriction, thus increasing heat transfer capacity. Guaranteed for 150 lbs. saturated steam pressure. Nine models.



HORIZONTAL TYPE
UNIT HEATERS

Proven, rugged, modern design. Quiet, guaranteed for use on 150 p.s.i. steam pressure. Heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Ten models.



YOU CAN DEPEND ON McCORD AIR CONDITIONING PRODUCTS

McCord RADIATOR & MFG. CO.
DETROIT 11, MICH.

MEETINGS & CONVENTIONS

Note: Listing compiled before government request on cancellation of national conventions after February 1.

Heating and Ventilating Engineers

American Society of Heating and Ventilating Engineers, 51st annual meeting, January 22-24, Hotel Statler, Boston. For details, see ASHVE Journal Section in this issue. The secretary of the ASHVE is A. V. Hutchinson, 51 Madison Ave., New York 10, N. Y.

Testing Materials

American Society for Testing Materials, committee week, February 26-March 2, spring meeting, February 28, Hotel William Penn, Pittsburgh. Annual meeting, June 18-22, Hotel Statler, Buffalo, N. Y. The ASTM headquarters office is at 260 S. Broad St., Philadelphia 2, Pa.

Products of Tomorrow

First National "Products of Tomorrow" Exposition, to open approximately March 1, Chicago Coliseum. The general manager is Marcus W. Hinson, Chicago Coliseum, 1513 S. Wabash Ave., Chicago, Ill.

Midwest Power Conference

Midwest Power Conference, eighth annual meeting, April 9-10, Palmer House, Chicago. Sessions are planned on recent developments in heating and air conditioning, feedwater treatment, fuels and combustion, the gas turbine, diesel power, central station practice, and hydro power. Prof. S. E. Winston, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill., is the conference director.

Foundrymen's Meeting

American Foundrymen's Association, 49th annual meeting, week of April 30-May 4, Detroit. No exhibit is planned in connection with the meeting. The headquarters office of the AFA is at 222 W. Adams St., Chicago 6, Ill.

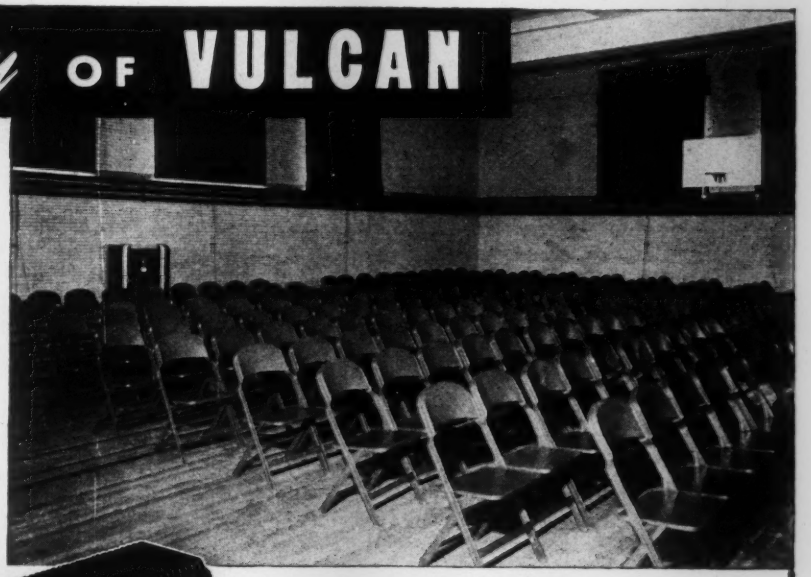
District Heating

National District Heating Association, 36th annual meeting, Deshler-Wallick Hotel, Columbus, Ohio, to be held late in May or early in June. John F. Collins, Jr., 827 N. Euclid Ave., Pittsburgh 6, Pa., is secretary of the NDHA.

Although the nation's output of bituminous coal reached a new peak in the last 12 months, consumption requirements will exceed production by from 10 to 16 million tons in the fuel year which ends next March 31, Solid Fuels Administrator Harold L. Ickes told members of the solid fuels advisory war council at its monthly meeting in Washington December 13.

An index for the year 1944 for Heating, Piping & Air Conditioning will be ready soon. If you want a copy, send a postcard to The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Illinois.

THE *Versatility* OF VULCAN



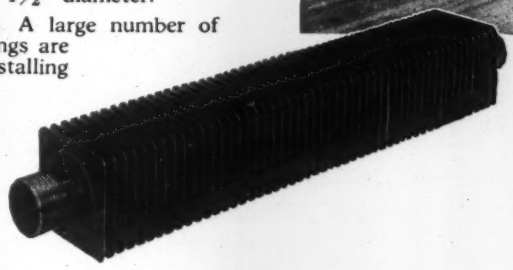
VULCAN, the accepted continuous line radiation, has proven extremely versatile in application. ***Here are some of its advantages:***

Light Weight. It is light and compact but strong and rigid. Sections come cut to length and ends are threaded or chamfered.

Uniform Heat. There is little temperature difference between floor and ceiling and horizontal temperature is uniform.

Greater Output. Maximum heat distribution is obtained with the Vulcan offset fin construction. One length of VULCAN 1¼" is equal to 8 pipes of the same length 1½" diameter.

Few Fittings. A large number of valves and fittings are eliminated by installing VULCAN.



VULCAN Radiation solved a heating problem in this auditorium. Radiators were installed easily up high out of the way. Down drafts were eliminated and even temperature control was maintained.

VULCAN—HARTFORD is stamped on every radiator.

SEND FOR CATALOG Showing Temperature Controls

THE VULCAN RADIATOR CO. **26 FRANCIS AVENUE, HARTFORD 6, CONN.**
RADIATOR MANUFACTURERS FOR ALMOST TWO DECADES

DON'T LET YOUR . . . IRON AND STEEL PRODUCTS

"Rust in Peace"

GIVE THEM LONG-LASTING PROTECTION WITH PENNizing.
Hot Dip Galvanizing for your iron and steel products is the ONLY sure way of guaranteeing long-lasting protection at the most economical cost. And the PENNizing process is the method of Quality Hot Dip Galvanizing as perfected by the Penn Galvanizing Company since 1910 . . . assuring LONG-LASTING PROTECTION against corrosion.

HOT DIP GALVANIZING
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GALVANIZED IRON AND STEEL PRODUCTS FURNISHED

PENN GALVANIZING CO.
"the Nation's largest"

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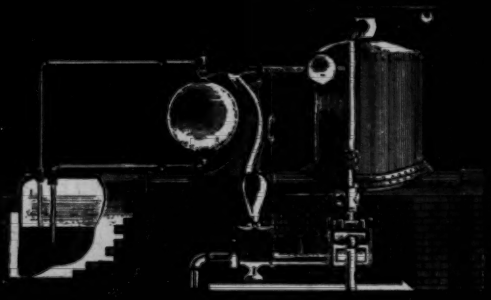
Gen. Offices: 2201 E. Tioga Street, Philadelphia, Pa.
PLANTS: No. 1, 2201 E. Tioga St. - No. 2, 2400 E. Tioga St. - No. 3, 3548 N. Sepviva St.

Advanced Design
1872



The Berryman Patent Regulator, assigned to Whitlock is acknowledged to be the most important device ever invented to promote safety and economy in the use of steam

Advanced Design
1945
WHITLOCK
AUTOMATIC
BOILER FEED SYSTEM•••

Just as the Patent Regulator was the superior product in 1872, the present Whitlock Automatic Boiler Feed System features the substantial advances since that time. Today's Whitlock system continues to *fit the job*, offering many modern advantages in safety and efficiency—collecting condensation returns, adding necessary make-up supply and feeding the boiler to maintain exact water level at all times. The simplicity of the Whitlock Boiler Feed System makes installation easy and keeps maintenance low. Send for Bulletin 80 and complete information.

The WHITLOCK
MANUFACTURING CO.

44 South St., Elmwood, Hartford 1, Conn.

New York Boston Chicago Philadelphia Detroit Richmond

In Canada: Darling Brothers, Ltd., Montreal

Ahead of the times for over Half a Century

NEW BOOKS & REPORTS

Codes for Prevention of Dust Explosions

The National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., has recently published National Fire Codes for the Prevention of Dust Explosions, 1944, superseding the 1943 edition, and including the 15 American standard codes, a new code for explosion and fire protection in plants producing and handling magnesium powder or dust, and an amended code for starch factories.

A statement of fundamental principles of dust explosion prevention in industrial plants and a record of 840 dust explosions which have occurred in the United States are other features.

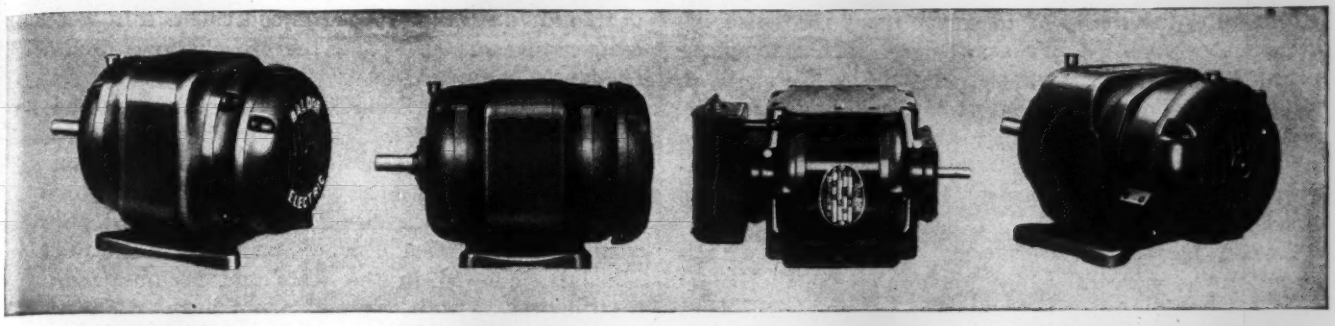
The volume covers such industries as aluminum bronze powder manufacturing, plants dealing with magnesium powder or dust, coal pneumatic cleaning plants, flour and feed mills, pulverized fuel systems, spice grinding plants, starch factories, pulverizing systems for sugar and cocoa, plants handling sulphur dust, country and terminal grain elevators, suggested good practice for the application of suction and venting for the control of dust in grain elevators and storage units, wood flour manufacturing, and woodworking plants. There is also a standard method of using carbon dioxide or other inert gas for the prevention of explosions and fires.

This 176 page book is available from the NFPA, bound in red cloth at $2.00 per copy postpaid, or bound in brown paper covers at $1.00 per copy postpaid.

Upper Limits of Tolerance to Heat and Humidity

Abstract of report on Upper Limits of Tolerance to Heat and Humidity, given by Lt.-Col. T. F. Hatch, Sn.C., Armored Medical Research Laboratory, Ft. Knox, Ky., at the ninth annual meeting of the Industrial Hygiene Foundation.

Man can tolerate dry heat well above 200 F, provided he is inactive and the duration of exposure is brief. On the other hand, if he is to carry on vigorous work for a prolonged period without loss of efficiency and with no significant rise in body temperature, the limiting environmental conditions will be found not far above the normal comfort zone. The acceptable limits will also be influenced by the age and physical condition of those exposed and their degree of acclimatization to heat. Finally, the limits will be determined, in part, by the criterion employed to define tolerance. Thus, it is seen that there is no unique point on any thermometric scale which can be said to represent *the* upper limits of man's tolerance to heat. Specific limits can be established only for clearly defined sets of conditions. It must be remembered, too, that there are four separate factors which, together, define the thermal environment, air temperature and moisture content, intensity of radiation, and air movement. Since various combinations of these four will yield equivalent en-



BALDOR glass-insulated motors are used for all applications; especially recommended where limited space and weight is a factor.

BALDOR totally enclosed motors, STREAMCOOLED DESIGN, available in 1 ph., 3 ph. and D. C.

BALDOR fan and blower motors, gimbal-mounted, assure Quiet Operation.

Fully compensated D.C. motors; available in standard and low voltage for truck, railway and traction service.

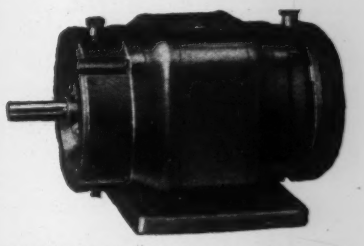
BALDOR face-mounted vertical motors; totally enclosed STREAMCOOLED DESIGN; 1 ph., 3 ph. and D. C.

BALDOR
BETTER MOTORS

Regardless of mechanical specifications and current characteristics required, Baldor is qualified by experience to handle your motor problems. The complete Baldor line includes all types of motors 1/20 to 20 H. P.

BALDOR ELECTRIC COMPANY, ST. LOUIS 10, MO.
District Offices in Principal Cities

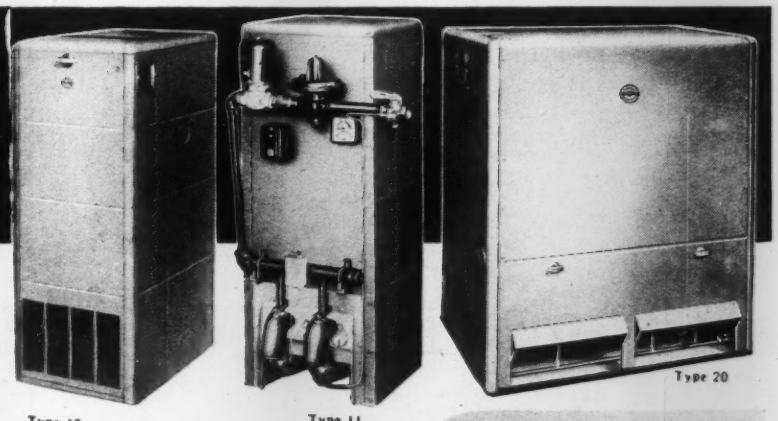
25th YEAR of engineering service to motor buyers



BALDOR face-mounted horizontal motors; totally enclosed, STREAMCOOLED DESIGN; 1 ph., 3 ph. and D. C.

Announcing

3 new Mueller *Climatrol* Gas Boilers



Type 10

Type 11

Type 20

for gas-heating installations you can really be proud of

Restyled for better appearance — redesigned for better performance — these new Mueller boilers are worthy successors to Mueller equipment which has been out in front since the earliest days of gas heating. Included is an entirely new burner design which is extremely quiet in operation. Many other new features — plus well-known Mueller quality. Write for bulletins. *L. J. Mueller Furnace Co., 2007 W. Oklahoma Ave., Milwaukee 7, Wis.*

Type 10 Type 11

for residences and small commercial installations

Type 10 has all controls and the backdraft diverter enclosed within the boiler jacket.

Type 11 has the diverter enclosed within the jacket, with controls exposed.

Type 20

for larger residences, apartments, stores, commercial and industrial buildings, etc.

Gas burner manifold and safety controls enclosed.

New wide range of sizes. Control equipment and trim interchangeable for either right-hand or left-hand end installation.

E-13

MUELLER *Climatrol* GAS BOILERS AND GAS-FIRED UNIT HEATERS

vironments, the limits of tolerance must recognize the influence of each. A dry atmosphere with a temperature of 120 F, for example, may be well tolerated, whereas a moist environment of 95 F will be intolerable. Similarly, if the intensity of radiant heat is high, there must be compensating decrease in temperature or moisture content or a sufficiently high air movement to offset it.

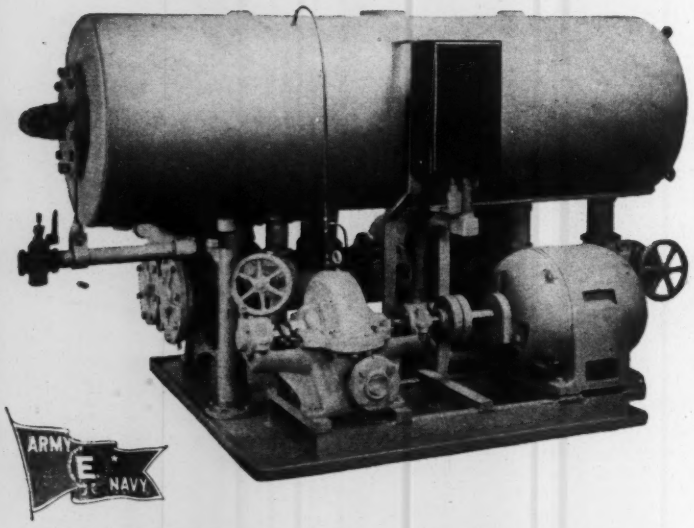
Among the early observations on the limits of tolerance were those made by Haldane in 1905. He defined the limit of endurance as the most extreme heat exposure which could be withstood without experiencing abnormal rise in body temperature. For the clothed, resting man not especially acclimatized, the maximum endurable temperature of saturated, still air was found to be 88 F. Haldane further demonstrated the beneficial effect of air movement, reporting that the tolerable wet bulb temperature was increased to 93 F at an air velocity of 170 fpm.

More recent work of the ASHVE Research Laboratory demonstrated close correlation between physiological reactions and the so-called effective temperature, which takes into consideration air movement as well as temperature and humidity. It was shown in these studies that the hourly rise of body temperature and pulse rate during heat exposure increased sharply when the effective temperature was above 85-90 deg in the case of the resting man and at lower ET values for the working man. Employing as the criterion of tolerance this point of marked increase in pulse rate and rate of rise of temperature, the maximum tolerable atmosphere has an ET of 90 deg or less. In still saturated air an ET of 90 deg is equivalent to a wet bulb temperature of 90 F and therefore agrees well with Haldane's findings.

Recent work by Eichna and associates* at the Armored Medical Research Laboratory has provided additional data on the upper limits of tolerance to heat and humidity. Observations were limited to a group of young men (average age 21.6 yr) in normal physical condition. They were previously trained to the working schedule followed in the tests and acclimatized to a high degree to both dry and moist heat. All tests for tolerance were carried out at a work rate of approximately 300 Cal/hr (marching at 3 mph, carrying 20 lb pack). The work period was 4 hr with a total of 7-8 hr per day continuous exposure in the experimental hot room. Subjects were quartered in neighboring barracks and were under immediate supervision throughout the test period of approximately two months. A total of 14 test atmospheres, closely controlled with respect to dry bulb and wet bulb temperatures, were studied. They varied in intensity from 93 to 121 F dry bulb and 90 to 96 F wet bulb. The temperature of the walls, ceiling, and floor of the room was maintained as close as possible to the air temperature in all tests, resulting in a mean radiation temperature of about 2 F less than the lower dry bulb temperatures to 9 F below the highest air temperature. No special air movement was set up, the subjects creating their own relative air motion by marching which resulted in average convection coefficient of 12 Cal/m²/hr/C, as measured on a heated cylinder wheeled around the test room with the

*To be published.

Boiler Feed Pumping Units



A star has been added to the "E" Award for Walter H. Eagan Company's high achievement in the production of Condensate Return Units.

- For use where boiler feed should be controlled by boiler water level.
- Where operation of boiler water make-up condensate return is combined.
- In process steam installations where little condensate is returned.

This is one of the various types of Condensate Return Units manufactured by Walter H. Eagan Co. No matter what your requirements, there is an Eagan Unit to do the job.

PUMPS

Write for General Catalog No. 2
Consult us on your requirements

WALTER H. EAGAN CO.

2336-38 FAIRMOUNT AVENUE, PHILADELPHIA, PA.

EXTENDED SURFACE

Trade Mark

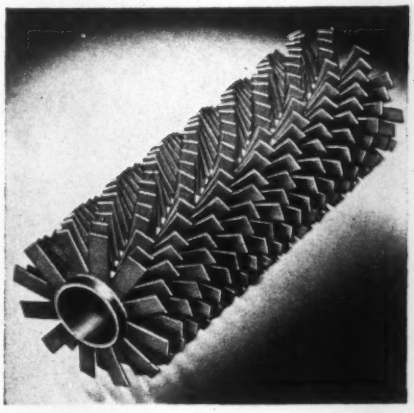
Manufacturers of "TILCO-FIN" and "WELD-ON" finned tubing

When cost is computed on the basis of B.T.U.'s per cubic foot of space occupied, this high transfer —low resistance surface has no equal.

Having open area in the direction of the tube it is especially applicable to heat exchanger design.

Can be supplied in all copper and all steel or any standard combination of metals.

Where steel is used the fins are continuously welded to the tubes thus making an ideal surface for high temperature applications.



Any size tube, fin height, and fin spacing can be supplied and inquiries are solicited for special as well as standard sizes and metals.

EXTENDED SURFACE

58 SECOND AVENUE, BROOKLYN 15, N.Y.

GETTING THE BURKS DEALERSHIP IS THE BEST MOVE I'VE MADE!
BURKS DEALER
20
LUCKY GUS! I WISH I HAD IT!
I DIDN'T THINK IT WAS TIME TO GO AFTER IT YET!
COMPETITORS

MAKE YOUR POST-WAR PLANS NOW —GET THE FACTS ABOUT A BURKS DEALERSHIP

When you hang up your BURKS Dealership shingle you're on your way to a prosperous, highly satisfactory water system business.

It's a dealership every one cannot get, but once you acquire it, you have 100% cooperation from the factory. All sales must come through our sales organization with NO EXCEPTIONS.

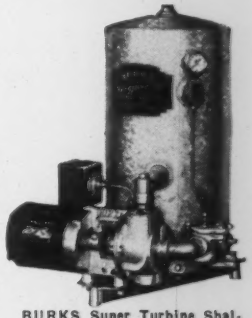
BURKS Water Systems are money makers for you and for the people who use them. They are precision built and finely engineered to give longer years of trouble-free service—to deliver more water per horsepower and to require less servicing than any other system.

Steady magazine advertising — effective direct-to-prospect mail campaigns — satisfied owners and engineering features no other system can offer — insure a volume of prospects and easier closures.

In short, the BURKS Dealership is mighty close to a good dealer's dream of a perfect setup.

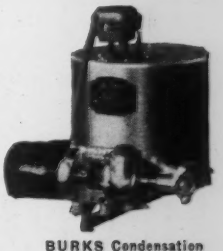
New dealers are now being appointed in all parts of the Nation—write us for complete details.

DECATUR PUMP CO.
41 Elk St. Decatur 70, Ill.

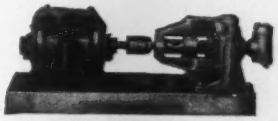


BURKS Super Turbine Shallow Well System

BURKS Vertical Educer Deep Well System



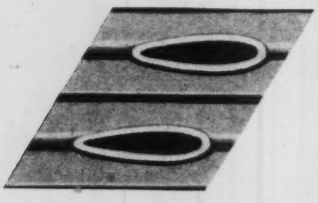
BURKS Condensation Return Units — both single and duplex types



BURKS Heavy Duty Super Turbine—Large capacity pressures up to 150 pounds

Announcing Series 15

UNIT HEATERS



with *Streamline* COPPER TUBES AND FINS

Every man who specifies, sells, installs and uses unit heaters should know about the combined air handling and heat transfer efficiency of Fedders new Series 15 Models.

In addition, they provide extreme ruggedness resulting from advanced wartime metal brazing and fabricating skills.

Send for new Catalog 15C-1 just off the press.

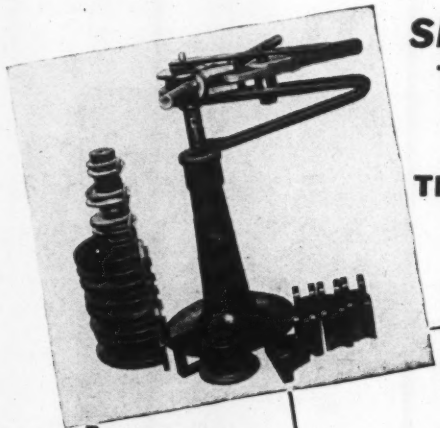
FEDDERS

BUFFALO 7, N. Y.

subjects. Salted, cool water was provided and the men urged to drink enough to maintain water balance. Subjects were nude except for shoes and socks.

The test of tolerance employed in this study was the demonstrated ability or inability to complete the assigned work during the 4 hr period. For each test environment, exposures were repeated until the subjects had reached peak performance or definitely demonstrated their inability to complete the assigned task for the 4 hr period. In the more severe environments various procedures were employed to persuade the men to carry on to their maximum ability. On one day each week the men were exposed to a relatively easy environment in order to recuperate from the severe stress of the test environments, and to provide "base day" observations. Direct observation of the subjects and their own subjective reactions, together with measurements of body temperature and pulse rate, provided the basis for a final decision with respect to any test environment. Other measurements included skin temperature, weight loss, water intake, urine output, and respiratory rates. Records were kept of the symptoms, complaints, and general appearance of the men during work.

On the basis of overall performance, considering work accomplished, subjective reactions and physiologic changes, averaged in every case for the whole group of 13 subjects, the results indicated that the 14 test environments fell into three distinct and readily separable groups, each including the entire range of dry bulb temperatures but differing from each other in the range of wet bulb temperatures: (1) "relatively easy"



SPEEDING THE WAR EFFORT of THESE BUSY PLANTS

"American"

COLD PIPE, CONDUIT and TUBE BENDING MACHINES

Bridge-builders, shipyards, engineering firms—busy with war work—depend on these machines! They'll speed peace-time conversion, too. *Twelve types:* hand operated capacities from ¼ to 6" inclusive; motor operated, ½ to 8" inclusive. *More than 12000 customers can testify to the dependability of "American's" 12 types of machines.*

A Few Of Our More Than 12,000 Customers: Bureau of Ships, Wash., D. C.; Henry J. Kaiser Co., Calif.; Pacific Bridge Co.; Bethlehem-Hingham Shipyards; Hercules Powder Co.; Stone & Webster; E. I. Du Pont de Nemours & Co.; Crane Co.

WRITE FOR PRINTED MATTER

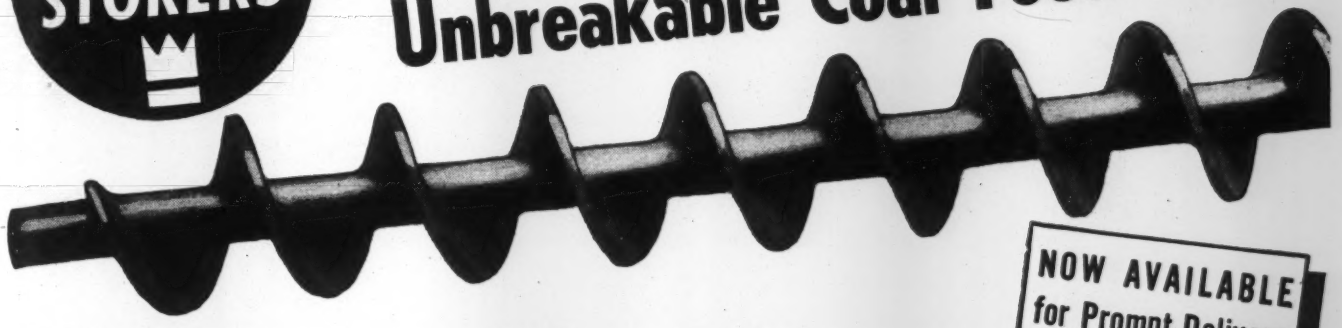
"American" PIPE BENDING MACHINE Company INC.

Quick Deliveries

51 PEARL ST. BOSTON, MASS.

For STOKERS

The CROWN Unbreakable Coal Feed Screw



NOW AVAILABLE for Prompt Delivery

WELDED All-Steel Worm—All Sizes—All Pitches

★ For replacement or production needs, Crown is now able to offer for prompt delivery its all-steel Coal Feed Screw. Available with right or left hand screw, in all sizes and pitches, tapered or straight, and in combinations of pitches. For both domestic and industrial stokers, the Crown Coal Feed Screw insures longer and continuous operation because it is all-steel and because it is machined so smoothly that wear is reduced to a minimum. This smooth surface is your assurance, too, that coal will flow freely and easily through the flights. Prompt delivery is possible because production requires less time on Crown's automatic machines and because the steel used in Crown's Coal Feed Screw while critical, is more easily procured.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

1202 Tyler St., N. E. *Since 1878* Minneapolis, Minn.

"COMMERCIAL"

VENTURI TYPE FAN HOUSINGS

Designed for unit heaters, exhaust and ventilating fans.

Formed in one piece with the Venturi section drawn without folds, cracks or welded parts.

We have increased our line of dies to cover a new range of sizes from 11⅝" to 53⅝" diameter openings and in 3 gauges of steel.

The use of "Commercial" fan housings lowers production costs, permits full efficiency of unit and gives an attractive engineered appearance.

The

COMMERCIAL SHEARING & STAMPING COMPANY

YOUNGSTOWN, OHIO

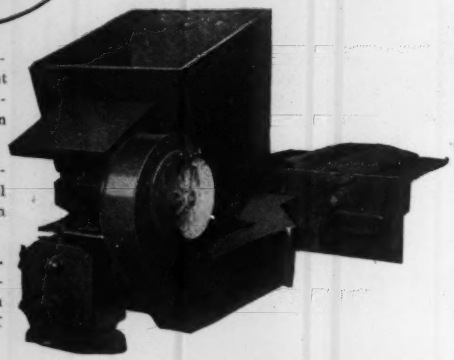
FREDERICK Stokers ... CUT DOWN WASTE

Do you get all the heat you pay for? Do you get every bit of heat out of every pound of coal? Here's what users say about FREDERICK Stokers:

Hotel Operator—"Satisfactory and efficient . . . saved one hundred tons of coal in one year."

Laundry Owner—"Present savings on fuel run greater than $1,000 per year."

Apartment House Owner—"A Stoker cannot give more than a FREDERICK Stoker."



We have been Stoker Specialists since 1918. The Improved FREDERICK Stoker line is the foremost stoker value in America because it is engineered to give the utmost in convenience and efficiency. Write for further details . . . ask for our Stoker catalog.

IT WILL PAY YOU—When considering a Centrifugal Pump . . . to investigate FREDERICK Pumps . . . specially designed for efficient service in your industry. Engineering consultation available with no obligation.

THE Frederick IRON & STEEL CO.
Frederick, Maryland

STOKER SPECIALISTS SINCE 1918

environments in which the work was readily accomplished without great effort or complaints and with all subjects alert at the completion of the work period and seemingly capable of continuing indefinitely; (2) "difficult" environments in which *all* of the subjects finished the assigned task of 4 hr continuous marching, but only with great effort, many complaints, and evidence of approaching exhaustion; (3) "impossible" environments in which the group of 13 test subjects as a unit never completed more than 1 hr of continuous marching and only two or three ever finished the 4 hr of work. The subjects were definitely exhausted and some frankly collapsed.

	Approaching Equilibrium Levels Environmental Group		
	Rel. Easy	Difficult	Impossible
Rectal temperature, F....	Below 101	101 to 102	Above 102
Heart rate, per minute....	Below 130	130 to 145	Above 145

The three different groups of environments are best described by their respective wet bulb temperatures which were found not to vary substantially within each group over the entire range of dry bulb temperatures, thus:

Environment	Dry Bulb-Range	Wet Bulb-Range
Relatively easy	92 - 120 F	92.5 - 89.5 F
Difficult	94 - 120 F	94 - 91.5 F
Impossible	96 - 120 F	96 - 94 F

Similarly, there was no great variation in ET within the three environmental groups.

DELUXE TYPE WK

De Luxe type WK Pressure Actuated Water Regulating Valves for Freon, Sulphur or Methyl, are pilot operated modulating. Standard adjustable opening range from 50 to 150 lbs. Factory set to open at 90 pounds. Precision engineering and individual testing for low cost satisfactory performance. Available in sizes of ¾ to 2 inches FPT. Simple adjustment—easily serviced.

Other sizes and types are also available.

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"THERMOSWITCHES" GET PLANES OFF FASTER!

Heating by "Ground Units" put our planes in the air with a minimum loss of time.

Write for catalogue and complete information . . . to

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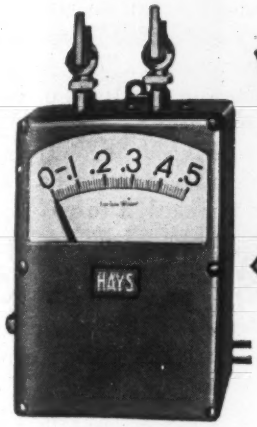

HOW DIRTY ARE YOUR FILTERS?

THIS GAGE TELLS

If you are confronted with the problem of not knowing when the collected dirt in your filters is of sufficient density to decrease operating efficiency, install a HAYS Air-Filter Gage. The HAYS indicator shows amount of air resistance at all times—tells when to renew filter element—eliminates guess work—can be made to sound alarm when resistance is excessive. Write for full information. Ask for HAYS Bulletin A-F G.

HAYS
AIR-FILTER GAGE

- *Automatic*
- *EASY TO INSTALL*
- *SAVES MONEY*
- *ELECTRICALLY OPERATED*

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
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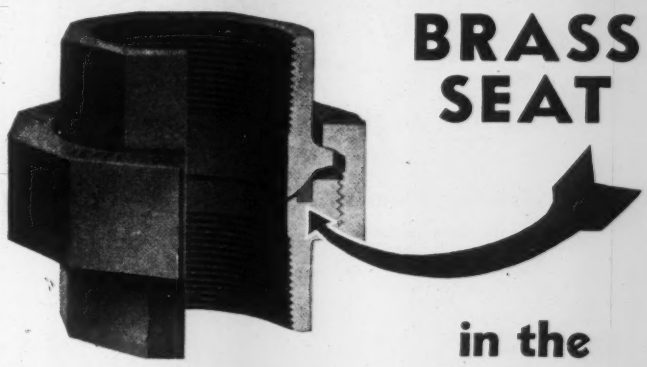

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is cut from seamless drawn tubing —free from all casting defects— sound and uniform always!

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Factories at
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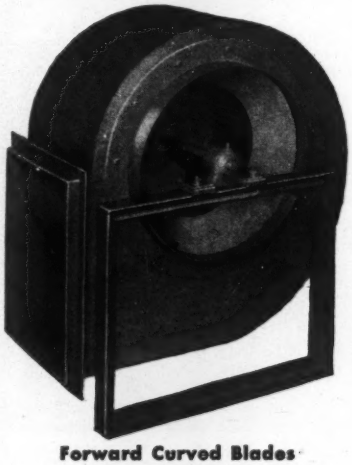

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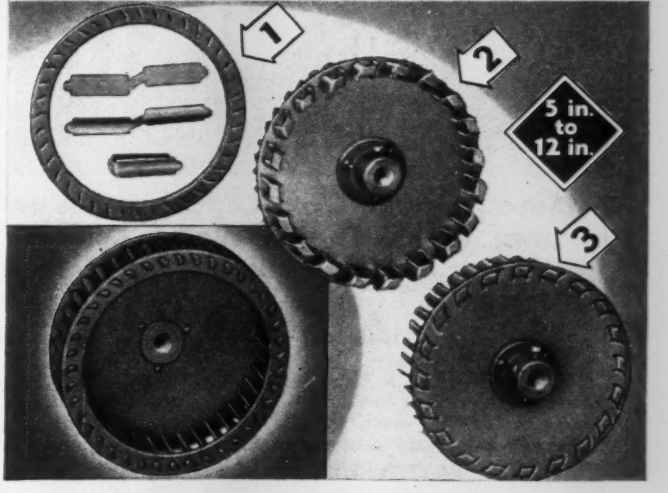
... Janette Blower Wheels



RUGGED and QUIET ▪ ▪ ▪ *because of this patented construction*

1. The steel inlet and back plate discs and slots are die cut to ensure exact spacing of blades. The blades are formed in pairs to increase rigidity.
2. A machined heavy cast iron hub is riveted to the back plate, then the blades inserted into the slots.
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Why Not Use These Rugged Wheels in Your Apparatus?

Janette Manufacturing Company
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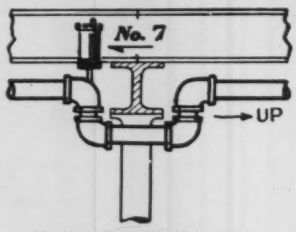
And Keep It Out With

AUTO-VENT AIR ELIMINATORS



Venting Trapped Mains and Circulating Lines.

Circulation Troubles?

Don't fight air pockets or traps in hot or cold circulating lines. "Get that air out of there" *and keep it out* simply by installing the No. 7 Maid-O'-Mist Automatic Air Vent. This reliable air vent has a self-closing float-controlled valve and is designed especially for circulating pipe lines, convector radiators, unit heaters, cooling manifolds, tanks, diesel engines, or any other application where air pockets or traps retard the free circulation of liquids. Now available in bright brass finish. For pressures up to 75 pounds.

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MAID-O'-MIST INC.

AUTOMATIC HUMIDIFIERS

211 NORTH ABERDEEN STREET
CHICAGO 7, ILLINOIS

The findings of this study strengthen but do not alter in any significant way earlier conclusions respecting limits of tolerance to heat and humidity. The higher tolerance levels must be interpreted in the light of significant differences in the test subjects, namely, as a limited age group of young men in good physical condition who were especially acclimatized for the test. In the consideration of these limits in relation to practical industrial problems, it must be remembered, too, that only two of the environmental factors—dry bulb temperature and moisture content—were deliberately varied; the influence of radiation and more particularly of air movement upon the limits of tolerance require further study.

Results of Ventilation Surveys in War Plants

Abstract of part of report on Findings from Foundation Surveys of War Plants, by W. C. L. Hemeon, M.S., and Francis R. Holden, Ph.D., Industrial Hygiene Foundation, at ninth annual meeting of the Industrial Hygiene Foundation.

Proper design of industrial ventilation is almost completely dependent upon industrial hygiene, as has been repeatedly illustrated in our work during 1944. For proper design implies knowledge of the *exact* sources of the contaminant, its toxicity and, frequently, existing concentrations. In many cases it is virtually impossible to proceed intelligently in the design of control equipment without the aid of industrial hygiene and its techniques, but one sometimes wonders whether in-

STOP THAT DRIP

No More Damage from Condensation or Sweating Pipes, Tanks, Walls, Ceilings and Air Ducts

NoDrip **A SURE CURE**

• This sensational plastic cork coating prevents condensation drip from metal, concrete, brick, wood, plaster or composition surfaces. Permanently protects metal against rust and corrosion, thus prolonging life of pipes, tanks, etc. Forms a moisture-proof, insulation type coating impervious to acid and alkali.

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FREE NoDrip Circular about Condensation Drip and its Prevention.

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ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS

For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

THE MARTOCELL CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

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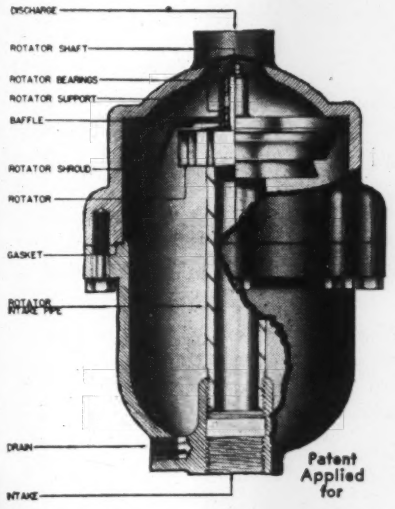
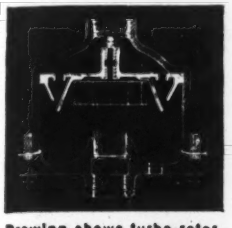
NEW TURBO-ROTOR *Pur-O-fier*

For Compressed Air

This new unit effectively eliminates moisture, oil and scale from compressed air lines. Pur-O-fier utilizes the principle of centrifugal force to separate entrainments from purified air. Once installed it requires absolutely no maintenance. Penstar Tru-Bond oiless bearing guarantees long, trouble-free operation. Manual or automatic drains provided.





Drawing shows turbo-rotor, shroud and baffles. The design of the baffles precludes the possibility of capillary action of entrainments resulting from high velocity.

THREE MODELS AVAILABLE—A-1 will accommodate volumes from ½ to 5 cu. ft. A-2, volumes from 10 to 35 cu. ft. A-4, volumes from 35 to 100 cu. ft. Multiple units are recommended for volumes above this range. Pur-O-fier is the only standard unit that can be engineered to meet any air volume for regular or intermittent service.

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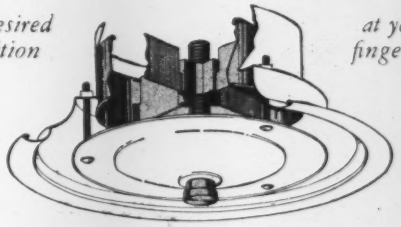
PROVIDES MAXIMUM EFFICIENCY
THROUGH CONTROLLED AIR DIFFUSION

Any desired condition — *at your finger tip*



KNO-DRAFT *Type K Adjustable Air Diffuser with Type D Volume Damper.*
Patented

All Kno-Draft Air Diffusers are also equipped with *air direction* adjustment to suit seasonal or individual requirements. Their engineered design insures more effective room air mixing, more uniform room temperature and controlled, noiseless, draftless air diffusion at low cost.

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PUBLISHED originally in serial form in HEATING, PIPING & AIR CONDITIONING, this important treatise by Leo F. Collins and E. L. Henderson presents the results of fifteen years of intensive research into every phase of the corrosion subject.

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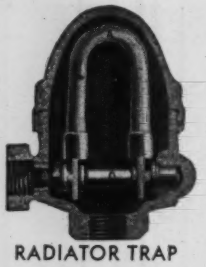
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HAINES TRAPS

With the Famous Bourdon Thermostatic Tube

THE operating member of Haines Traps—the famous Bourdon Thermostatic Tube—is the strongest thermostat ever built into a steam trap. The Bourdon Tube is used in gauges where accuracy is paramount; therefore, Haines Traps always give accurate performance.

Haines Traps are so constructed that they can be examined under pressure. You simply remove the cover and all working parts are before you.

Haines Float & Thermostatic Traps are designed for any low pressure job up to 15 lbs.; they cannot become air bound; the Haines underslung valve principle assures safety. No danger of building up a pressure. In ¾", 1" and 1¼" sizes.

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PHILADELPHIA 23

dustrial physicians do not appreciate their dependence upon the industrial hygiene engineer to a greater extent than do plant engineers.

Buying Industrial Ventilation—The manufacturer with a health hazard in his plant who needs specialized ventilation would have no problem if he could obtain bids from different contractors or equipment producers in which each bidder would guarantee to meet a specification to reduce the dust concentration to below, say, 10 million particles per cubic foot, or the vapors to less than 100 parts per million. But contractors and equipment companies will not make such guarantees and their reluctance is readily understandable.

The foundation meets this difficulty for its companies by providing specifications that form a connecting link between the atmospheric concentration required and engineering language that is understood by contractors. These Industrial Hygiene Foundation specifications provide a common basis for obtaining bids and for the writing of contracts. The IHF specifications, in effect, guarantee an adequate end result in terms of air concentration while permitting considerable latitude to equipment companies and contractors.

Ceramics—Consideration has been given to dust control for masons in glass and similar plants, and in particular to a portable exhaust unit for a brick cutting saw in common use in that trade. We have been concerned in a number of plants with designs for minimizing dust around clay and flint storage bins, unloading freight cars, and subsequent material handling. The shipment of flint with moisture is a measure of advantage.

THIS SIMPLE TEST SHOWS WHY KEY-TITE SEALER IS LEAK-PROOF

Rub a bit of Key-Tite between your thumb and forefinger. See how it "pulls" and stretches. Get the smooth feel—like a lubricant; it doesn't crumble or break.

Key-Tite has a double function. It lubricates as it seals. That's why it is the perfect waterproof sealer for all lines carrying water, gas, steam, compressed air. It seals immediately and never "freezes" in the joint.

Your jobber can supply you. Write us for a free sample.

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NEW Low Cost Regulator

Will Not Rattle . . . STAYS in Position

The Dial Damper Regulator No. 13 utilizes a new regulating mechanism instead of the finger tip control plunger. This popular and dependable type regulator is built for those jobs requiring a sturdily constructed regulator that embodies positive control features at a reasonable price. It is being used and recommended by some of the largest war-time shipbuilders.

The Dial Damper Regulator No. 13 will fit any size pipe, round or square. It is extremely light in weight, simply installed in a few minutes without special tools. Open and shut positions made by moving handle from left to right. Position held positive by tightening wing nut on handle. Will not rattle . . . stays in position always! Write for details.

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PEDRICK AUTOMATIC BENDERS

(Patents applied for)

Will bend thin wall tube into serpentine or box coils where low cost and high production are required.

In writing, state production requirements.

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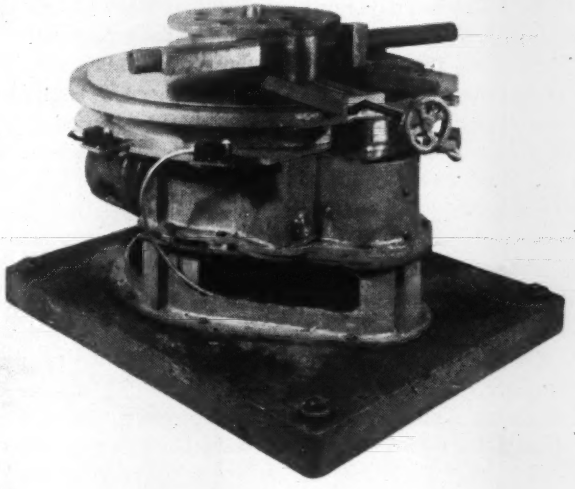
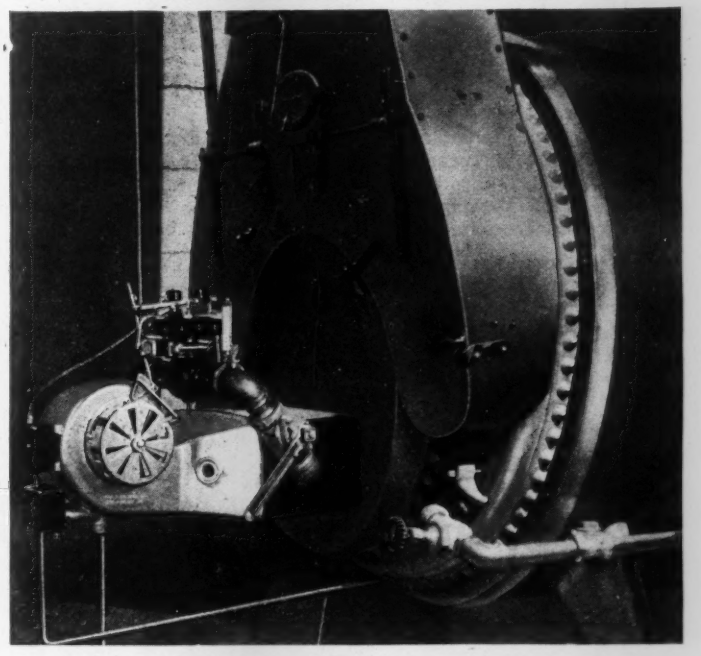


The C-2 Pipe Bender Shown Above Is Used for This Service When Equipped with the Pedrick "Magic Control." (Pat. applied for).

The Mettler "FAN-AIR" Gas Burner

As Applied to Scotch Marine Boilers

NOTE THE SIMPLICITY OF THIS APPLICATION



A Modern Complete Gas Burner System

"Fan-Air" is a mechanical draft fully automatic gas burner system—ideal for difficult jobs and can be used under natural draft operation also. Nothing else like it. Sizes 5 to 300 B.H.P. Qualified dealers wanted.

Ample Stock of Fan-Air or Natural Draft Burners for Prompt Shipment

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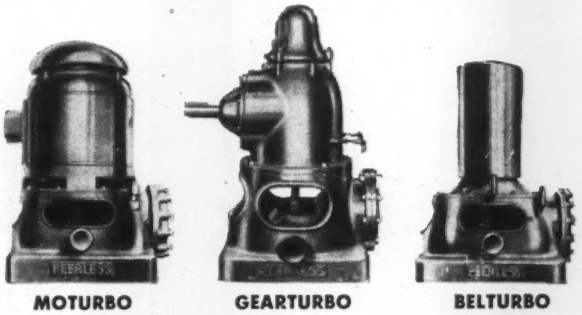

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Peerless-pumped water pays daily dividends

WATER is usually considered industry's cheapest commodity—but too frequently it costs more than it should. Lowered efficiencies increase power bills. Pump breakdowns are costly, not only for repairs but in interfering with production. Now, with the installation of a Peerless Pump, three objectives are accomplished: (1) Water is pumped at the lowest cost; (2) Because of the exclusive engineering design, construction and fine workmanship of the bowl and impeller assembly, *original efficiencies* are closely maintained over a greatly extended performance period, far beyond normal; (3) Pump repairs are reduced to the minimum.

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PEERLESS PUMPS

PEERLESS PUMPS

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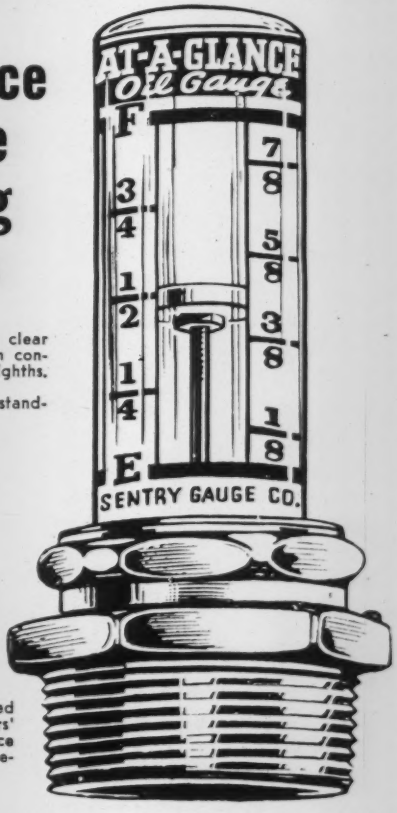
At-A-Glance Oil Gauge Has 6 Big Features



1. It is easy to read, large clear figures, large indicator disc in contrasting colors. Calibrated in eighths.

2. It is easy to install on any standard tank.

3. It is simple and fool-proof in operation. Lever action moves indicator up and down.

4. It has Lucite housing for transparency, oil resisting and durable.

5. It is leak proof. At-A-Glance Gauges withstand pressure test of 100 lbs.

6. It is neat, compact, ruggedly constructed for long, trouble-free service.

"At-A-Glance" Gauges are listed as standard by Underwriters' Laboratories. Install At-A-Glance Gauges. Write for complete details today.

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The Pipe Joint Cement that goes farther

Rutland Pipe Joint Cement gives you more bulk per pound. That means it goes farther and saves money. Seals joints tightly—lasts indefinitely—yet always leaves pipes easy to disjoin. Remains soft in can. Does not stain hands or fixtures.

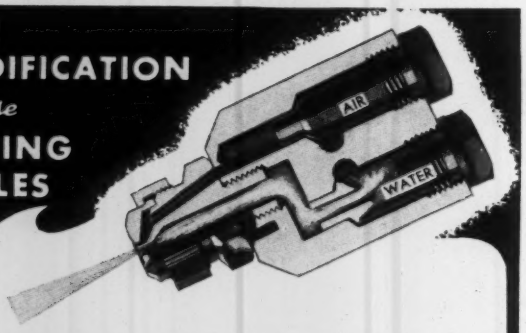
Mail post card for free sample. Rutland Fire Clay Co., Dept. H-25, Rutland, Vt. Also makers of Rutland Retort Cement, Furnace Cement, Asphalt Paint, Concrete Patcher.

Washed Silica Sand—The object of one of our investigations, conducted in a sand washing plant, was to determine what additional measures for dust control might be necessary in and around the sand drying equipment. A most interesting observation resulted. Notwithstanding the fact that there were several opportunities for material spillage in elevated conveying equipment and the like, and there were deposits of dust on all horizontal surfaces, there was no silica dust hazard in the plant. Dust counts were uniformly low. If this plant were handling dusty sand there would certainly have been a serious dust hazard, but the fine silica dust had been largely removed in the elutriation process and it was therefore practically impossible in this equipment to create important dust concentrations.

This finding means that in the plant of the consumer mere handling of washed sand would be very unlikely to cause hazardous dust concentrations. We have contrived a dustiness index which permits a comparison of different sands in terms of millions of dust particles per gram of sand which we anticipate may become useful to producers.

Asbestos—Electron photomicrographs of a specimen of airborne asbestos dust obtained by us in a member plant disclose some interesting facts. Asbestos dust particles at ordinary magnifications do not appear at all fibrous as would be expected. However, under high magnification of 15-20000 times with the electron microscope it is demonstrated that they are overwhelmingly fibrous and that the ultimate fiber appears to be about 0.01 microns in diameter.

BETTER HUMIDIFICATION *with these* SPRAYING NOZZLES



These siphon type pneumatic atomizing nozzles are designed to provide better humidification, more dependable nozzle performance and minimum maintenance. Each nozzle has its own air and water line strainer . . . can be cleaned while complete system is in operation. Humidifying assemblies are supplied with nozzle, pipe, valve and fittings.

The complete Spraying Systems line includes all types of nozzles for air washers . . . nozzles and all fabricated parts for roof spraying systems, spray cooling towers and spray ponds.

"Whirljet" Nozzle for air washers and cooling systems.

Your copy of the new Spraying Systems catalog is ready now. Contains complete facts and engineering tables—send for it today.

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SPECIALISTS IN THE DESIGN AND MANUFACTURE OF SPRAY NOZZLES

EASY TO READ DIAL THERMOMETER
Economize WITH POWERS TEMPERATURE REGULATORS
POWERS
Use a Powers No. 11 Temperature Indicating Regulator when you want the advantages of an easy-to-read dial thermometer combined with a dependable self-operating regulator. The dial thermometer gives a visual check on the performance of the regulator and makes it easy to adjust for the required operating temperature. Various dials and ranges are available.
Is Easy To Install—because both the thermometer and the regulator operate from the same thermal system—only 1 tapped opening is required.
Write for Circular 2511.
THE POWERS REGULATOR CO.
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CONTROLS HEATING OR COOLING MEDIUMS
POWERS
OVER 50 YEARS OF AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

VISOLEAK FINDS 'EM

RED SPOT FURNISHES CLUE TO REFRIGERANT LEAK DETECTION

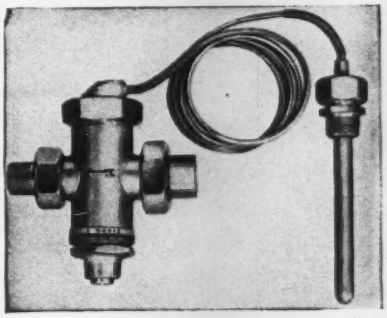
VISOLEAK is a finely-treated colored refrigerant oil which penetrates every nook and cranny of the system. The leak is indicated by a red stain – similar to the discoloration on a carburetor in which ethyl gasoline has been used. Can be used *safely* and *effectively* with any type of refrigerant. See your jobber today. If he has not stocked Visoleak write for complete information.

WHOLESALE PRICES		CASE LOTS
4 ounce bottle	$ 1.00	48 bottles
8 ounce bottle	1.75	24 bottles
1 pint bottle	3.00	24 bottles
1 quart bottle	5.00	12 bottles
1 gallon can	16.00	6 cans

SAVE 10% ON CASE LOTS

WESTERN THERMAL EQUIPMENT CO.
5141 ANGELES VISTA BLVD., LOS ANGELES 43, CALIFORNIA.

LOWER FUEL COSTS



Accurate Hot Water Temperatures with this STERLING No. 150 Control

Control temperature automatically, conserve fuel and SAVE MONEY by installing the efficient, self-contained and self-operating STERLING No. 150 Series Control. Engineered to maintain accurately regulated temperatures for hot water storage tanks, heat exchangers, stills, etc. Pressures up to 125 lbs., temperatures to 250° F.

Write for bulletin No. 402. Consult your local jobber for catalog and prices.

Fuel-Saving Starts With CONTROL

STERLING, Inc.
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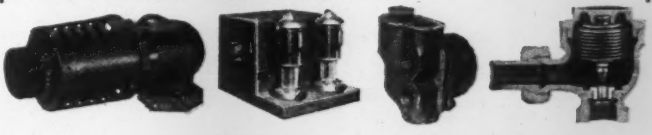
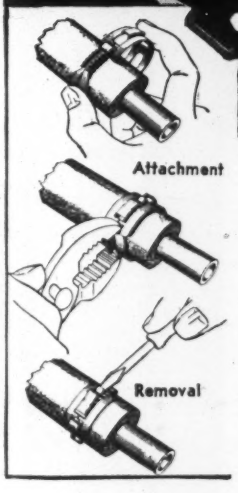


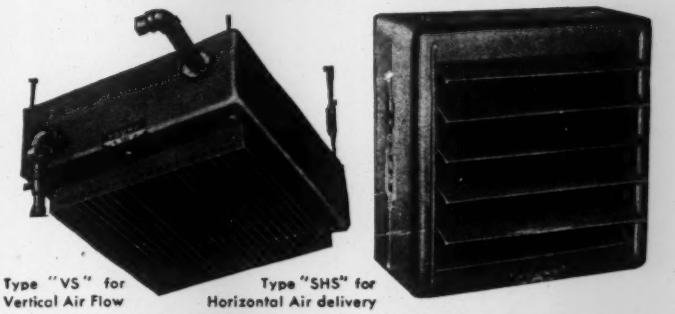
THE *New* TINNERMAN HOSE CLAMP



This new one piece hose clamp can be installed and removed *easier* and *faster* because of its simple but sturdy ratchet-type locking mechanism. It weighs less, has a lower profile, exerts uniform pressure and may be used over and over again. Approved by Army Air Forces and Navy Bureau of Aeronautics. Sizes from ½" O.D. up. *Write for information.*

TINNERMAN PRODUCTS, INC.
2018 Fulton Road - Cleveland 13, Ohio

WARM UP *the* COLD SPOTS
WITH YOUNG UNIT HEATERS



Type "VS" for Vertical Air Flow

Type "SHS" for Horizontal Air delivery

"Streamaire" Unit Heaters can be used to advantage whether the area to be heated is large or small. Their saving of floor space, ease of installation, efficient operation, low "first" and maintenance costs, make them desirable for existing or new buildings. If you have a heating or air conditioning problem write or consult the nearest Young representative.

YOUNG RADIATOR COMPANY
Dept. 115-A, Racine, Wisconsin, U. S. A.
REPRESENTATIVES IN PRINCIPAL CITIES

YOUNG
HEAT TRANSFER PRODUCTS

Oil Coolers • Gas, Gasoline Diesel Engine Cooling Radiators • Intercoolers • Heat Exchangers • Engine Jacket Water Coolers • Unit Heaters • Convectors • Condensers • Evaporators • Air Conditioning Units • Heating Coils • Cooling Coils • and a complete line of Heat Transfer Equipment for Aircraft.